Vol. V. — No. 11. November 1923.

BULLETIN

OF THE

INTERNATIONAL RAILWAY CONGRESS

ASSOCIATION

ENGLISH EDITION

[625 .61 (.06]

Proceedings of the XVIIIth International Congress of tramways, light railways and public motor vehicle services,

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The International Union decided to resume, in October 1922, at Brussels, the City in which it was founded and in which its Committee have their permanent offices, the series of Congresses that had been interrupted by the world war.

The Belgian Government had given its patronage and nine foreign governments had sent delegates to the Congress.

More than 350 membres, coming from nineteen different countries, met in Brussels on the 3 October, the date of the opening meeting of the Congress.

Mr. Neujean, minister of the Belgian State Railways, presided at this Meeting supported by baron Ruzette, his colleague of the Public Works Department; by Mr. Beco, the governor of Brabant; by Mr. Ad. Max, the burgomaster of Brussels; by Mr. C. de Burlet, the president of the International Union and by many other officials.

The Minister of Railways drew attention to the economic and social importance of tramways, of light railways and of public motor vehicle services. He expressed the hope that the result of the work of the International Union would be to solve the many and serious problems that affected the transport industry at the present time.

Mr. de Burlet, president of the Union, then traced the history of this body. He spoke of its modest origin in the era of horse traction and of its rapid development dating from the introduction of electric traction. He alluded to the sad reminders of the war period which remain and proceeded to consider the reconstruction that is at present taking place at this the beginning of the motor traction era.

Mr. de Burlet dealt with the very important place that transport had taken in the life of large urban communities and also with rural populations. He showed how powerful the influence of transport could be in promoting social peace as well as the moral and material advancement of the population. He drew

attention to the difficulties that had affected nearly all enterprises since the war. He cordially invited all specialists to study the administrative, financial and technical problems that were before them. He gave it as his personal opinion that communications made during the Congress would lead to the solving of various problems.

In the absence of Mr. A. Mariage, managing director and president of the « Société des transports en commun de la région parisienne » (Paris District General Transport Company), Mr. Bacqueyrisse, general manager of the company, read a report on the following subject : « An investigation of the increase in expenditure above the pre-war figures on tramways, light railways and public motor vehicle services. — Expenses of installation and working ».

Mr. Mariage said that he had obtained the data, which he was placing before them, from 67 tramway companies, 32 light railways, and 9 motor service companies. Among these companies were numbered the most important undertakings of this class in France, Belgium, Spain, Holland, Italy, Switzerland, Sweden, England and Poland.

The years chosen for the comparison were 1913 — the last year of normal economic life, 1920 — which appears to mark the culminating point in cost of living, and 1921 — the starting point, is to be hoped, of a gradual decrease towards a more stable economic position.

From 1913 to 1921, the number of kilometres of tramway track and the number of vehicles running had practically not been increased. It is found that generally speaking, an increase has taken place in the number of passengers carried per car kilometre, particularly in the case of all the belligerent nations.

The increase in receipts is, however, not sufficient to balance the expenditure which has increased more rapidly. It has been necessary to seek a remedy for the financial deficit by increasing the fares.

The belligerent countries have been compelled to make the largest increases and, in no case, except that of Switzerland, have these met the expenditure. In every country the increases were authorized too late.

A great general increase has been found in the working expenses particularly under the heading of « labour ».

The numerous tables and graphical diagrams accompanying Mr. Mariage's report clearly show the various conclusions at which he arrived.

When the cost of installation is considered, the situation with regard to working is no better, because, apart from the increased cost of labour and of materials, the rate of interest on loans is higher than it was before the war.

The conditions that have been found in the working of tramways have also been found to be practically identical in the case of the working of light railways.

With regard to the working of public motor vehicle services there are only two companies, those working in Paris and London, that have been able to furnish particulars for the year 1913. The other concerns are of more recent origin.

In this section also the conclusions are identical with those arrived at for tramway working.

From a study of the whole of the observations the Reporter concludes that the various managements have encountered most serious difficulties since the war. These appear to be decreasing gradually, but, in the case of many concerns, the situation continues to be precarious.

In almost all cases the systems appear to require some improvements; it is very necessary that these should be underta-

ken, but the work is held up on account of the excessive cost.

It is also necessary to look for technical improvement : the Congres of the International Union will be of powerful assistance in this.

The members of the Congress who spoke in the discussion on this Report quoted particular cases which fully confirmed the observations of Mr. A. Mariage.

* * *

The application of electric welding or other similar methods to tramways : « Track and workshop work » formed the subject of an investigation dealt with by Mr. d'Hoop, manager of the Brussels Tramways. This paper was read by the Author.

After describing the different methods of welding by the electric arc, M. d'Hoop mentions its applications to the construction and maintenance of the track. Usually the fishplates are retained at the joints of the welded rails. The bolts are either omitted altogether or used in smaller numbers. The connexion between the fishplates and the rails at the head and at the sole is made by means of fillet welding with electrodes. Some companies, moreover, reinforce the joints by means of plates applied below the sole of the rail and connected to it by fillet welding with electrodes.

A few companies have abolished the fishplates altogether. In this case the soles and webs of the rails have additional metal at the joint and the head of the rail is strengthened by fillet welding with electrodes.

Arc-welding is of special interest for the repair of old and damaged tracks. It enables the tread to be built up where hollows or depressions have been formed, near the joints. This addition of metal is followed by a grinding operation to ensure a true surface. The rolling stock will then run over the track without appreciable jolting.

Welding is also of importance for the construction and repair of points, frogs, crossings, etc. It enables the life of these parts to be increased appreciably.

Various parts made of manganese steel can be repaired in the same way by the use of appropriate electrodes.

With regard to work carried out in the shops, which lends itself to the use of the arc, Mr. d'Hoop mentions : « The underframes of vehicles in which some of the riveting may be abolished, the repair of broken parts, the making good of worn parts, etc. »

The restoration of the profile of the tyres of worn wheels by means of added metal is an important example of this application. Automatic or semi-automatic machines can be used for this work and thus effect an appreciable economy over the old method of restoring the profile by turning in the lathe.

Passing on to the description of the plant used, the Reporter states that the most suitable form of electric arc for welding requires only 20 to 25 volts. Continuous current or alternating current are equally suitable.

In the working of tramways, where continuous current at a tension of 550 to 600 volts is available, this voltage is reduced either by means of resistances arranged in series with the arc, in the case where the energy lost in doing the work is not great, or by means of rotary transformers. In these latter the dynamos are specially constructed to give the desired voltage. These dynamos can be arranged so as to supply the current to one or more arcs at the same time. In the latter case each of the circuits should be fitted with suitable regulating appliances.

The workmen who do the welding require to have their eyes protected by means of masks fitted with coloured glasses.

Needless to say the metal used for the electrodes plays an important part in the success of arc welding.

The form of electrode used is that of wire or rod from 5/64 to 15/32 inch in diameter and about 18 inches in length.

The electrodes are either bare metal, flux-covered or coated.

Bare-metal electrodes are the most economical, are suitable for the addition of large quantities of metal, and for use when the work is entrusted to highly experienced workmen.

The metal of the electrodes should meet the physical and chemical conditions required in the weld.

Flux-covered electrodes are covered, by dipping, with a coating of material which becomes solid on drying. This material serves the double purpose of guiding the arc and forming a flux for the metal.

Finally the coated electrodes have a core of soft steel or homogeneous iron surrounded by a coating containing other necessary metals as well as the flux.

After having spoken of the skill which the welders must acquire, Mr. d'Hoop passes on to describe the methods used for performing similar work to that obtainable from the electric arc.

He describes in succession :

The Falk joint, in which a lump of cast-iron, cast in place, encloses the ends of the rails.

Aluminium welding (thermit) is used for rail-joints, for making points and crossings and for repairs of broken parts.

The welding of rail-joints by thermit gives excellent results and a large number of tramway companies have adopted this method for new or slightly worn rails.

Mr. d'Hoop then alludes to the oxy-acetylene blow pipe which is used for certain work in the shops, and also on the tracks for brazing electric connexions.

He mentions the Sandberg thermal treatment which hardens the surface of the steel as a means of prolonging the working life of the rails.

Mr. d'Hoop finally expresses the opinion that the use of electric arc-welding will enable considerable economy to be effected in the construction and working of tramways. He forecasts its further use and recommends that steps be taken to train the necessary specialised workmen. He hopes for official recognition and the standardization of the technical points relating to electric welding.

The members of the Congress who took part in the discussion on this Report agreed in recognizing the economical advantages that are obtainable by adopting welding processes.

* * *

Mr. Blain, assistant managing director of the London Underground Railways and London General Omnibus Company, which form one group, had prepared a Report on the organization of motor bus services in a large town, which was read by a member of the Congress.

Mr. Blain deals with the organization existing in London.

The London General Omnibus Company is an enterprise which has 149 lines of a total length of 1 992 miles, whilst over 3 000 omnibuses are in use. The staff amounts to more than 21 000 employees. The longest run is 28.6 miles in length.

In London there are radial lines that bring the inhabitants of the suburbs to the centre of the city; circular lines that connect the suburbs with each other and lines running to the outskirts of greater London connecting London to neigbouring towns and centres of attraction within a radius of 30 miles.

Thirty-two garages distributed over

the zone served by the buses enables the distance run with light loading, at running out to and returning to the regular route to be reduced to a minimum.

In the garages nothing is done but cleaning and daily inspection. All the main overhauls are centralized in a special workshop.

Omnibuses with roof seats are almost exclusively in use. Only on about 27 % of the days is the weather in London such that it is more suitable to travel under cover. In view of the congestion of traffic in the streets, it is necessary to find room for the maximum number of passengers on a given area occupied by the vehicle.

The type S motor bus, the latest pattern, carries 54 passengers of which 28 are outside. This is the type which will be generally adopted as the old types are replaced.

All the rolling stock is constructed in the works of a Company associated with the General Omnibus Company.

The Omnibuses are required to meet a very exacting specification drawn up by the Metropolitan Police.

This specification has for its object the ensuring of the safety of the passengers and also of the users of the roads. It deals with the brakes, the radius of the turning circle, the wear of the paving of the roads, noise, and the comfort of the passengers.

In each of the garages the Traffic Management lays down for the employees the services which they are to perform and deals with the checking of the fares taken, while the technical service looks after the daily maintenance of the mechanical parts.

A plan of a typical garage arranged for 100 buses is attached to Mr. Blain's Report.

In order to reduce the distance run empty on leaving and on returning to the garage each line of buses is served normally by vehicles that are housed in two garages situated near the extremities of the line.

As each bus enters the garage it is first filled with petrol and the inside is cleaned; it is then taken to the washing machine for cleaning the outside. The vehicle, having been put into place for the night has the main parts of the chassis examined by special men who put right any small defects, noticed by the drivers who have been in charge of the buses, and fill up records for statistical purposes.

Each day 5 % of the total buses attached to the garage are subjected to a more thorough inspection of the driving gear. Defective parts are replaced by complete units kept in reserve in each garage. The dismantling and repair of engines, of clutches, of gear boxes, of back-axles, etc., are only effected at the central workshop.

Detailed statistics are kept of the parts of the chassis, of the consumption of petrol, of oil, of grease, etc.

The central workshop which has an area of more than 30 acres comprises a department for the complete construction of new vehicles and a department for repairs and tuning-up.

A perfectly methodical organization of the work has enabled a saving of 40 % to be effected in the time required for the overhaul of a chassis and has reduced the number of days, during which a vehicle is not running in each year, from 17 to 5 for general overhaul.

The company has founded an apprenticeship school for those who join its staff.

The Metropolitan Police issues licences to drivers after examination and badges are given to the conductors after enquiry as to character for honesty.

The company has organized canteens and various other schemes for the welfare of its staff.

Mr. Blain explains the method adopted for selecting the routes to be worked by

the motor buses. He says that for London the long lines that start from the outside, pass through the centre and terminate at the outside give the best results. The mobility of the motor bus gives it a great advantage over the tramways; the routes can be modified according to requirements.

The organization of the service on each line should be suited to its own class of traffic and the allocation of the staff should be arranged to suit this.

Mr. Blain states that in order to give the public a satisfactory service, it is necessary that the fares should allow for covering expenses of all kinds and give a reasonable remuneration for the capital invested in the enterprise.

The fares should be such that they can be easily understood by the public and applied without difficulty by the Company's staff. Fares arranged by zones are most general and are the only rational arrangement for large cities.

Many graphical diagrams, photographs, and specimens of printed matter in use in London were attached to the Report of Mr. Blain.

After the reading of this Report a delegate of the Paris District Transport Company gave a summary of the situation relating to the Paris motor buses.

Buses with roof seats have been given up in Paris. The normal type of bus can carry 38 passengers and, on lines having very heavy traffic, 6 wheeled buses for 48 passengers have been running for some little time. The fuel used consists of a mixture of benzol and alcohol.

* * *

The Report of Mr. Spencer, general manager of the London Group of Tramway Companies, on the latest improvements in rolling stock of tramways was then read.

The Author compares the rolling stock of English and American tramways. In the latter country a great change has been observed during the last fifteen years. In England there has been no appreciable alteration.

For the last ten years automobile vehicles running on rubber tyres have been rapidly improved up to a point at which the public has begun to find fault with the tramcars, particularly with regard to their noisiness and slowness. Mr. Spencer has investigated methods for overcoming these disadvantages.

He proposes to reduce the noise, produced by the running of the cars, by laying the rails on wooden sleepers instead of carrying them direct on concrete as is the usual practice in England. The disastrous effect on the tracks of the unsprung weight of the driving axles should also be avoided.

Why have not tramway engineers followed the example of the builders of automobile chassis ? These have reduced the unsprung weight to a very small amount.

The use of special steels, of light alloys, and of new methods of transmission between the motors and the axles might lead to the desired result on tramways.

A considerable saving could be realized on the weight of the electric motors of the vehicles. The weight might be reduced from 70 to 20 lb. per H. P.

Mr. Spencer expresses the opinion that the construction of a tramway wheel comprising an insulating body between the tyre and the wheel centre in order to reduce noise and vibration would be of great use.

In order to raise the average or commercial speed on tramways without reducing the safety of users of the roads by running at too high a maximum speed requires increased acceleration at starting and increased deceleration for stopping.

The Reporter predicts the use of shunt-

wound motors with a view to obtaining uniform acceleration. He also mentions briefly the advantage of recuperation rendered possible by these motors. Finally he finds that the substitution of contactors for controllers would be of advantage.

He also predicts mechanically operated brakes with a view to obtaining increased deceleration for stopping.

The displacement of the trolley wheel off the wire is also one of the causes of the low over all speed on tramways. Mr. Spencer mentions the trial of a sliding contact which reduces the frequency of failure to make contact with the overhead wire. Passing to the construction of the tramcar bodies, he recommends a careful investigation on similar lines to those undertaken for the motor bus bodies.

The arrangement for taking the fares on entering the vehicle called « Pay on entering » requires special arrangements. Mr. Spencer thinks that it will be necessary to find a method of construction that will renders this system applicable even in the case of fares arranged by zones.

Finally, the Reporter mentions a trial made on one of the London United Tramway lines, carrying light traffic, of a tram worked by a single employee who performs both the operations of taking the fares and driving the vehicle. He states that this trial has proved satisfactory.

Mr. Spencer's paper gave an opportunity to the delegate of the Paris District Transport Company to give the members of the Congress a description of the light tramway car which has been brought out as a result of investigation and trials by this company.

This vehicle, of which the *Review of the Tramway, Light-Railway and Public Motor Transport Industry* (1) gave a description recently, is noteworthy on account of the reduction of the total weight by 2 1/2 tons and reduction of 18 cwt. in the unsprung weight. Perfect stability is obtained by means of the long wheel-base 11 ft. 9 3/4 in. without introducing difficulty in taking curves. The convenient body arrangement, with a central platform, and the small consumption of electric current per kilometre run are other advantages of this vehicle. Contrary to ordinary practice the two electric motors are arranged longitudinally and drive the axle by cardan shafts and bevel gears.

* * *

The following question based on the Agenda of the Congress: « Cars worked by a single employee » has been investigated by Mr. Nieuwenhuys, manager of the Municipal Tramways of Arnhem.

Automotor vehicles worked by a single employee, known in the United States of America as « safety cars » have been constructed in that country since 1916, in accordance with the designs of the inventor Mr. Birney.

They have met with considerable success on account of the saving in wages and in electric current they effect by the quicker service given, the starting and stopping being very rapid.

The one-fare system which is very general in the United States is a great help to the employees on the safety cars in taking the money. Passengers get on and off the car by the front end. Payment is made on entering.

When the passengers have entered or left the car the driver closes the door and raises the step. This operation is

(1) *L'Industrie des tramways, chemins de fer d'intérêt local et transports publics automobiles*, August 1922.

performed by compressed air and must be carried out by means of interlocking gear before the car can be started.

In order to provide against the result of the driver being taken suddenly ill while driving, the handle of the controller is fitted with a knob which can be depressed. As soon as this is released by the driver the current is cut off, the air brake applied to the wheels and the sand boxes turned on. Moreover, the door of the car is opened and the step lowered in order to enable the passengers to get down. The « Birney safety car » has seating capacity for 28 passengers.

The electrical equipment comprises two 25 H. P. motors of very light construction and the complete gear is specially constructed for this type of car.

The introduction of the safety cars has not met with opposition from the staff of the American Companies. When these cars were put into service, the companies increased the frequency of the service on their lines and they consequently were able to retain all their staff.

The public received the improvement favourably, and, thanks to proper publicity, rapidly became accustomed to the restrictions imposed by working with a single employee.

In October 1922 more than 6 000 « safety cars » were running in the United States.

Mr. Nieuwenhuys quotes the good results obtained in many American towns where, in consequence of the great increases in costs of working that have occurred since 1914, the financial situation had become critical.

On suburban lines, where the zone-fare arrangement is in force, modifications have had to be made in the standard type of « safety car ».

The change consists often in the arrangement at the back of the vehicle of a doorway fitted with a door enabling passengers to leave the vehicle, but not to enter it.

In order to improve the financial position of the tramways of Arnhem, Holland, Mr. Nieuwenhuys placed before the Municipal Authorities a proposal to adapt the cars to working by a single employee. At the same time he increased the service in order to obtain the best efficiency for working.

The changes in the vehicles were made as economically as possible. They consisted in the fitting of doors to the platforms, of lifting footboards, and of mechanism for returning the controllers to neutral position.

As in the « safety car » the entrance and exit are arranged in front near the driver.

The Arnhem lines worked by these modified vehicles have one fare only; the issue of tickets does not therefore cause any difficulty. The cars can carry 18 passengers seated and 14 standing.

The tramway staff did not raise any objection to the introduction of the system.

Slight delays have arisen owing to giving change, but generally the service works well. The public is becoming accustomed to the system and the length of the stops is tending to diminish.

Encouraged by this result Mr. Nieuwenhuys proposes to make the change on cars of larger capacity running at Arnhem.

Entrance will be by the front platform and passengers will leave by the back platform. The working of the doors and of the footboards will be effected by means of electric motors. An automatic door will prevent people getting on by the back platform. The safety arrangements intended to prevent accidents in case of sudden illness of the driver will be supplemented by an electro-magnetic shoe brake acting on the rails.

The Report of Mr. Nieuwenhuys is accompanied by drawings of the apparatus,

platform doors, footboards, controller gear, and automatic doors as used at Arnhem.

* * *

Mr. De Croës, chief engineer and Manager of the Belgian National Light Railways Company (Société nationale belge des chemins de fer vicinaux) had been entrusted with the making of a Report on « The working of light railways by automotor vehicles ».

After having noted the limitations of the field open to steam automotor vehicles and the narrow range to which electric accumulator automotors are applicable, the Reporter considers that automotors vehicles fitted with internal combustion motors will prove a satisfactory solution to some problems.

As compared with steam trains these automotor vehicles are much more economical because they require a smaller staff and an expenditure of fuel that is strictly proportional to the work done. Moreover, the supply of water becomes negligible and the tracks suffering less wear under light vehicles will cost less to maintain.

The mechanical transmission between the motor and the wheels, as normally arranged on vehicles running on roads, appears to be suitable only for light automotor vehicles.

Electric transmission becomes necessary for powerful tractors.

Mr. De Croës mentions the important bearing which the question of the use of economic fuels, on which much work is being done at present, has on the development of automotor vehicles.

The Reporter gives a review of the applications made in England, Belgium and America, of automotor vehicles running on rails. He describes the recent trials made in France.

Mr. Tartary on the Deux-Sèvres tramway system uses extra-light rolling stock similar to the motor bus with remarkable economy. The cost of working per car-kilometre, all charges included, does not exceed 1 fr. 10.

Well known firms, Renault, de Dion-Bouton, Berliet and Scemia, have commenced designing automotor vehicles for running on rails.

They appear to prefer vehicles that are heavier than those used by Mr. Tartary.

Some constructors predict a single position for the driver; others who follow electric motor vehicle practice arrange a driver's place at each end of the vehicle.

This latter arrangement is evidently desirable with a view to ease in working.

As an example of an automotor with electric transmission the Reporter mentions that supplied by the Crochat works to the Toury-Pithiviers line. In this case the net cost has been 1 fr. per kilometre run.

Automotor vehicles and tractors on the Diesel-electric system working on Swedish lines are mentioned and figures given of their working expenses.

The Reporter concludes that the petrol automotor car can, in some cases, when the traffic is light, be more economical than the steam tractor; statistics, however, do not yet enable the price to be fixed definitely in advance for the cost of working any particular line by automotor vehicles. The arrangements to be adopted for the vehicles are not yet sufficiently well established by custom. The use of economical fuels must be pushed actively.

From the discussion that followed the reading of this Report, it would seem that the application of automotor vehicles on light railways is essentially a particular case.

At the present time the function of these vehicles is to supplement the steam locomotive.

Opinions are divided on the question

of the double driver's cabins and on the weight of the vehicles.

* * *

Mr. Odermatt, engineer to Brown, Boveri & Co., Ltd, read his Report to the Congress on the use of mercury vapour rectifiers for tramway systems.

The problem of the transformation of alternating current into continuous current is one of particular interest from the point of view of electric traction. In this field the use of continuous current is becoming more and more important. Alternating currents have on the other hand, indisputable advantages, thanks to the facility with which they can be carried economically over great distances. It is therefore desirable to be able to convert energy in the form of alternating current into energy in the form of continuous current under the best possible conditions.

The mercury vapour rectifier is a static apparatus, free from losses due to friction or magnetic flow. Its efficiency is proportional to the voltage and reaches 95 to 99 % whereas that of motor generator groups is about 86 % and that of rotary converters about 94 %.

The working of the mercury vapour rectifier is based on the property possessed by a metallic electrode at high temperature, of emitting electrons in a vacuum which cause ionization by impact on the surrounding medium. In a vacuum chamber containing two electrodes these electrons guided by the electrostatic field pass from the cathode to the anode. In the rectifiers the cathode consists of a mercury bath and the anode of a piece of iron. The valve action of the rectifier is not a special property due to a peculiarity of the mercury vapour arc, but is a phenomenon independent of the nature of the cathode. This phenomenon is the result of the arrangement of the two electrodes, of which one (the cathode) on account of its heating, becomes the centre of emission of electrons while the temperature of the other is maintained sufficiently low to avoid this emission.

An apparatus, arranged as described above, fed directly from a source of alternating current only allows an intermittent current to pass and does not utilize the output of generators and receivers efficiently if, between the source of alternating current and the rectifier, there is arranged a static transformer of which the primary is supplied by the source of current and of which the secondary has a neutral point (the negative pole of the continuous current system, the cathode serving as the positive) and if the two ends of the secondary winding are connected each to one anode the whole of the complete sine curve will be used. Thus, in the continuous current circuit (with purely ohmic resistance), a unidirectional current is obtained having a high degree of pulsation, which, shown graphically, is represented by a sinusoidal curve of which, the negative half-wave is reversed. In such an apparatus the undulation of the rectified current may be diminished by the insertion of a reactance coil in the circuit. The secondary of the transformer should be designed for a current 1.41 times that of the primary (theoretical value).

It is also possible to reduce the undulatory form of the rectified current by using several phases. This has led to the making of six-phase, twelve-phase, and polyphase rectifiers.

The rectifier generally used is the six-phase apparatus for which the undulations are so slight that the rectified current may practically be represented by a straight line. The difference of potential between each anode and cathode is only approximately 20 volts and each anode only gives out current during the period in which the instantaneous value

of the corresponding voltage exceeds the instantaneous value of the voltage of the other phases.

Mr. Odermatt has fixed the relationship that exists between the various voltages and currents to be taken into consideration and shows that in practice, for the six-phase rectifier, the value of the effective current of the anode is equal to that of the continuous current divided by a co-efficient the magnitude of which varies from 2.8 to 3.2. The transformer for complete supply must be designed for an apparent power 1.6 times the continuous current power given in kilowatts. This power may be reduced to 1.46 times the continuous current power by the use of reactance coils (called absorption coils) placed on the negative side of the continuous current circuit. These absorption coils have also the effect of limiting the pressure-drop of the plant between certain limits.

The Cooper-Hewitt rectifier has been known since 1902. It is the prototype of the present large-output rectifier and it was the attempt to eliminate the disadvantages of the glass rectifier (of limited capacity, short life in service and fragile character) that led to the use of the steel container. Brown, Boveri & Co., Ltd., of Baden, are at the present time making three types for currents of 300, 600 and 1 000 amperes at 650 volts. Above this voltage the current rating decreases slightly as the voltage rises. The maximum voltage actually obtained in a *single* unit is 6 000 volts for a maximum power of 2 000 kw. Mr. Odermatt describes the apparatus in question; he mentions the precautions that have been taken for cooling by water circulation and for maintaining the vacuum, the maintenance of a high vacuum being a *sine qua non* for the apparatus to work properly.

The Report mentions the necessity for inserting self-induction coils in the anode circuits with a view to equalising the load taken by anodes working in parallel. The Reporter describes arrangements for starting and exciting. The self-induction coils cause a loss of about 1 % of the power of the rectifier, and the special exciter for maintaining the temperature of the cathode causes a loss of approximately 650 watts. The vacuum pump absorbs a total amount of power equal to 1.2 kw. Cooling may be effected by running water or by a refrigerant circulated by means of a pump absorbing about 0.4 kw. Starting is simple; supervision consists of nothing but the checking of the vacuum, and the cost of maintenance is practically negligible. Parallel operation of several rectifiers requires no special precaution; these appliances can easily be run in parallel with other converters. The adjustment of the continuous current voltage which is generally of no importance for traction purposes can only be obtained by a corresponding variation of the alternating current supply (step switches on the transformers or induction regulators). The apparatus behaves particularly well with overloads, sudden rushes of current and short-circuiting.

Mr. Odermatt devotes a section of his paper to an account of the advantages shown by the mercury vapour rectifier :

1° High efficiency, constant at all loads;

2° Simple setting to work and minimum attendance;

3° Minimum wear and insignificant cost of maintenance;

4° Insensibility to current surges and short circuits;

5° Light weight, absence of foundations and costly lifting appliances;

6° Small space occupied;

7° Absolutely silent working.

The loss of power in a rectifier depends on the drop of voltage in the arc. This is constant and equal to about 18 volts for all loads. The efficiency

proper of the rectifier is therefore constant at all loads. It improves as the working voltage is increased. Its value becomes equal to 95 % for 350 volts, it increases to 96.5 for 500 volts, to 97 for 600 volts, and to 99.2 % for 2 400 volts.

The commercial efficiency of an installation with rectifiers is greater than that of an installation with rotary converters and *a fortiori* better than that of an installation with motor-generators. In an installation of 200 kw. working at the mean power of 80 kw. the efficiencies are 94 %, 83 % and 62 % respectively.

Brown, Boveri & Co., Ltd., have up to the present put into service or have under construction 190 rectifier installations comprising 390 units of a total power of 102 000 kw. the greater number of these installations are intended for traction work.

Mr. Odermatt gives brief notes on the subject of some existing installations and concludes by drawing attention to the superiority shown by the rectifiers particularly in automatic installations where, to other advantages, can be added that of the economy effected in the staff.

* * *

Mr. A. Pirard, managing director of the « Société anonyme d'entreprises générales de travaux », of Liége, had prepared a report on the various current systems that could be used in the electrification of light railway systems.

In the first portion of this paper Mr. Pirard mentions the characteristic features, the advantages and the disadvantages of the various systems that may be considered for the supply of current to secondary lines of railway.

The solution adopted for urban tramways (continuous current at 500 to 600 volts) generally leads, for secondary railways, with the exception of the cases of lines of short length and heavy traffic, to too great expense in first cost. This can be reduced by the use of higher voltage either with three-phase current, or single-phase current, or continuous current.

Three-phase current is not economical because of the complication in the overhead conductors.

Single-phase current, the voltage of which may be very high (12 000 to 15 000 volts) requires only a single contact wire. On the other hand the cos. φ is small; the motors are large (which it is particularly important to consider in the case of metre-gauge lines); the periodicity should not exceed 25 if good commutation is desired; finally, the working of the system is capable of causing disturbance in the adjacent telephone and telegraph circuits. The contact line is generally of the simple catenary type.

Mr. Pirard continues his investigation by examining the question of the economic aspect of electrification and of the selection to be made amongst the various systems for the supply of current to the line.

In the national interest in countries poor in fuel, electrification on a large scale may be predicted in those districts that have water power. In all other cases, the decision will depend on the comparison of the total cost of amortization and of the interest on the capital required with the saving to be obtained by the substitution of electric traction for steam traction.

The main factors tending to economy are :

1° The reduction in the expenditure of fuel which may amount to from 50 to 65 %;

2° The reduction in labour and cost of maintenance. This element is variable and the substitution of electricity for steam may, in some cases, cause an increase in expense;

3° The probable increase in the traffic.

The choice between the different possible systems of current supply will be determined by the comparison of the annual total expenditure (interest on and amortization of capital to be invested plus the cost of energy to be consumed in the case of each system).

Mr. Pirard makes a comparison under definite conditions between single-phase current and continuous current. Taking account of the load on the system, of the efficiency of the sub-stations and of the lines and of the cost per kilowatt-hour he arrives at the following conclusions :

When the primary distribution is effected by three-phase current at a periodicity greater than 25, continuous high-tension current will be preferable :

1° If the system is small in area;

2° If the system is of great area and :

a) the price per kilowatt-hour is high;

b) the number of ton-kilometres is very large;

3° When it is necessary to avoid disturbance in the adjacent telegraph and telephone lines.

Single-phase current will be adopted on systems of great length when the cost of current per kilowatt-hour is low and the traffic is light.

Basing his argument on examination of what has been done up to the present Mr. Pirard predicts the adoption, according to circumstances, of the following :

1° Continuous current at 600 volts for lines of short length and heavy traffic;

2° Continuous current at 1 200 to 1 500 volts on suburban lines of sufficient length (at least 20 km.; 13 miles) carrying moderately heavy traffic;

3° Continuous current at higher voltage (1 800, 2 000 or 2 400 volts) in the case of longer lines with few and rather heavy trains;

4° Single-phase current when the traffic is light and electrification is only justified by the low cost per kilowatt-hour of current together with high cost of coal, the consumption of which would be increased for steam trains by reason of the profile of the line.

* * *

Mr. L. Sekutowicz, manager of the technical service of the Omnium Lyonnais, read his Report to the Congress on automatic sub-stations.

In the first part of his report the Author states the problem to be solved and gives a history of the use of automatic sub-stations. They were used first for traction, more recently for other services, at static transformer stations, and with mercury vapour rectifiers.

These sub-stations have the characteristic feature that the manipulation instead of being carried out by an electrician is effected by apparatus acting by means of servo-motors. If there is complete automatic working, the starting of the machines is effected by the action of a clock or of a relay working at minimum voltage. If the sub-station comprises several machines these are started successively by the action of a maximum-ampere relay or a thermometric relay inserted in the circuits. Stopping is effected by the action of the minimum-ampere relay through which the sub-station current flows.

Mr. Sekutowicz recalls what operations have to be performed in the case of rotary converters and what protective appliances require to be installed. He draws particular attention to the most delicate operation which, in the case of these machines, consists in ensuring proper polarity when the machines are started and he describes the

arrangements worked out for this purpose by the G. E. Co., the Westinghouse Co., and Brown, Boveri & Co. In automatic sub-stations in America, an arrangement intended to limit the load is fitted to the dynamos and, often also, to the « feeders ». Cut-outs have been perfected. General use is made of circuit-breakers with controlled relocking, of extra rapid circuit-breakers, and of circuit-breakers that only work in case of short-circuiting. The machines (rheostats, bearings, windings) are protected against overheating by thermic relays.

The second part of the report is devoted to a detailed description of the four chief types of automatic sub-stations. The third part includes descriptions of recent arrangements, it mentions the results obtained, and the advantages that may be gained by the use of automatic sub-stations.

Mr. Sekutowicz mentions the advantages due to the use of a general « dispatcher »; he investigates the use of resistances intended to limit the load on the dynamos and on the feeders, and he discusses the precautions to be taken against short-circuiting. He gives the results of trials carried out on sub-stations on an interurban line and estimates of the cost of first installation and working.

The advantages of the system are :

Requires no attention by the staff;

Saving in labour;

Reduction of waste when running light and at low load;

Reduction in the cost of « feeders »;

Increase in safety of running due to the use of improved protective apparatus.

Ordinary sub-stations may benefit by some of these advantages, but, if the necessary expense is incurred to this extent, there should be no hesitation in adopting complete automatic working which would not increase the cost.

* * *

A last report on the Agenda of the Congress was that of Mr. Rochat, general manager of the Geneva Electric Tramway Company on « The Economic Position of the Swiss Railways from 1913 to 1920 ».

This memoir comprises so large an amount of statistical data relating both to normal gauge railways, to mountain railways, to light railways, and to tramways that it is impossible to give it in abstract.

[625 .113]

A method of introducing transition curves,

By Reginald Braham ROBINSON,
ASSOC. M. INST. C. E.

Figs. 1 and 2, p. 994.

(*Minutes of Proceedings of the Institution of Civil Engineers.*)

In fitting a spiral to an existing curve it is necessary to shift the whole curve inwards by a certain amount, which may be as much as 1 1/2 feet. It may not be possible to move the curve by so much, on account of bridges, insufficient formation, or other causes; but it may be possible to shift the curve by a small amount in such cases. If the spiral number n (length of spiral in which curvature is changed one degree) be made smaller, the shift is reduced, but the spiral loses its value.

The following method (fig. 1) shows how n may be kept the same and yet the shift be reduced by not less than one-half. T, T are the tangent-points, W the intersection, and O the centre of a curve of radius r and degree of curvature θ. Let s denote the shift. The angle of intersection is 2α

Let D be the centre of the arc TDT.

Set out a new curve, touching the two tangents, and having a reduced radius r' so that if D′ is the centre of the new arc

$$DD' = s$$

Now

$$WD = WO - OD$$

$$= \frac{r}{\cos \alpha} - r$$

$$= r \frac{(1 - \cos \alpha)}{\cos \alpha}.$$

Similarly

$$WD' = r' \frac{(1 - \cos \alpha)}{\cos \alpha},$$

therefore

$$WD - WD' = DD' = s = (r - r') \frac{(1 - \cos \alpha)}{\cos \alpha}.$$

and

$$r - r' = \frac{s \cos \alpha}{(1 - \cos \alpha)},$$

thus

$$r' = r - \frac{s \cos \alpha}{(1 - \cos \alpha)}$$

which gives the value of

$$r' \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

Now with centre O′ and radius $r' - s$, describe a third curve of radius r''.

$$r' = r' - s \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

This curve passes through D, the centre of the original curve, and is tangential to a new line T″A″ which is parallel to TA and distant s from it. A cubic parabola spiral may now be fitted between the new curve and the straight TA by the customary method. It will be observed that the shift at the centre of the curve is nil and at a point between

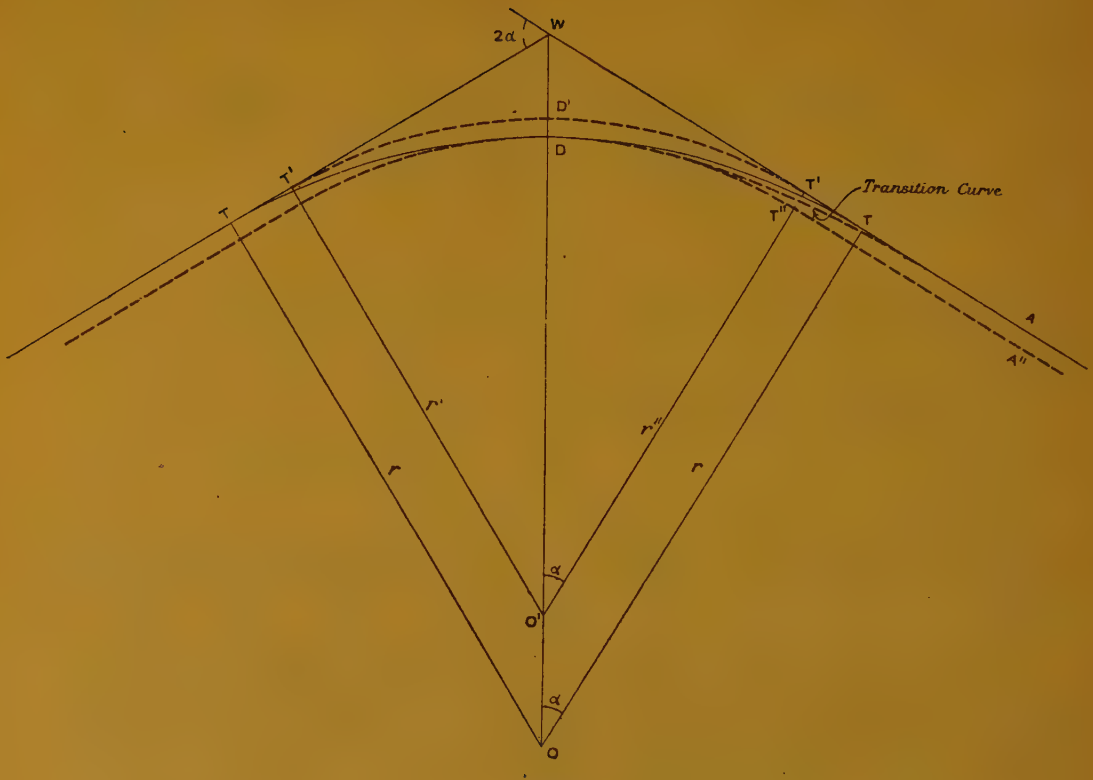
W
2α
D'
D
T'
T
T'
T''
T
Transition Curve
A
A''
r'
r''
r
r
α
O'
α
O

Fig. 1.

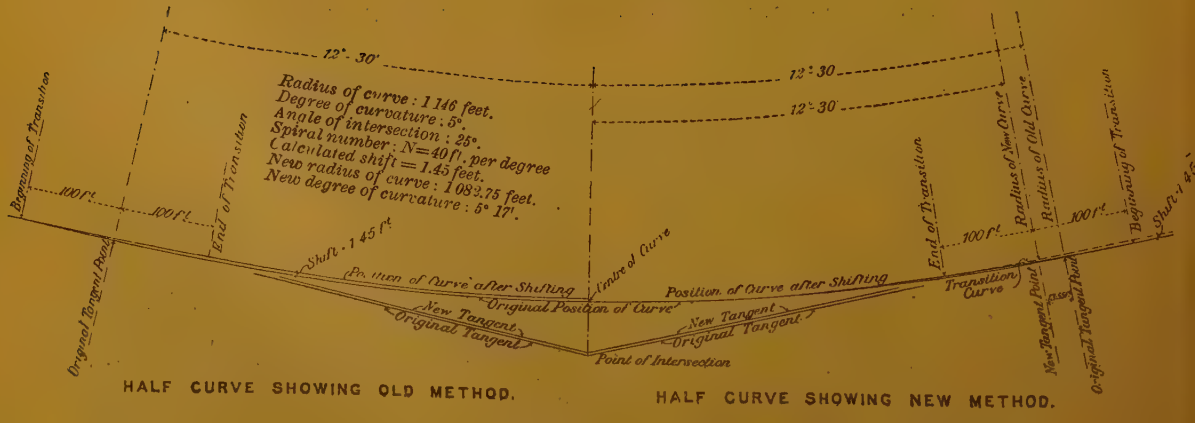
12° 30'
12° 30'
12° 30'
Radius of curve : 1146 feet.
Degree of curvature : 5°.
Angle of intersection : 25°.
Spiral number : N=40 ft. per degree
Calculated shift = 1.45 feet.
New radius of curve : 1082.75 feet.
New degree of curvature : 5° 17'.
Beginning of Transition
100 ft.
100 ft.
End of Transition
Shift - 1.45 ft.
Original Tangent Point
Position of Curve after Shifting
Original Position of Curve
New Tangent
Original Tangent
Centre of Curve
Point of Intersection
End of Transition
Position of Curve after Shifting
Transition Curve
New Tangent
Original Tangent
Radius of New Curve
Radius of Old Curve
100 ft.
New Tangent Point
Original Tangent Point
Beginning of Transition
HALF CURVE SHOWING OLD METHOD.
HALF CURVE SHOWING NEW METHOD.

Fig. 2.

Table I.

$_0\theta$	Shift and half length of spirals : Feet. $s = \frac{n^2\theta^3}{137520}$										
	n : 5	8	10	12	16	20	25	30	40	60	80
1	...	...	...	. .	...	...	...	...	...	...	0.03 40
2	...	...	...	...	...	...	...	...	0.09 40	0.21 60	0.37 80
3	...	...	...	...	...	...	...	0.18 45	0.31 60	0.71 90	1.25 120
4	...	...	...	..	...	0.19 40	0.29 50.0	0.42 60	0.74 80	1.67 120	...
5	...	...	...	...	0.23 40	0.36 50	0.57 62.5	0.82 75	1.45 100	...	...
6	...	...	...	...	0.4 48	0.63 60	0.98 75.0	1.41 90	...	...	...
7	...	...	...	0.36 42	0.64 56	1.0 70	...	...	...	...	...
8	...	...	0.37 40	0.54 48	...	...	...	...	...	...	...
9	...	...	0.53 45	0.76 54	...	...	...	...	...	...	...
10	...	0.47 40	0.73 50	1.05 60	...	...	...	...	...	...	...
11	...	0.62 44	0.97 55	...	...	...	...	...	...	. .	...
12	...	0.81 48	...	...	...	...	...	...	...	...	...
13	0.4 32.5	1.02 52	...	...	...	...	...	...	...	...	...
14	0.5 35.0	...	...	...	. .	. .	...	...	...	...	...
15	0.61 37.5	...	...	...	...	...	...	...	...	...	...
16	0.75 40.0	...	...	...	...	...	...	...	...	...	...
17	0.89 42.5	...	...	...	...	...	...	...	...	...	...

Table II.

x Feet.	Offsets for spiral : Value of y : Feet. $y = \frac{x^3}{34380\,n}$										
	n : 5	8	10	12	16	20	25	30	40	60	80
25	0.09	0.06	0.05	0.04	0.03	0.02	0.02	0.02	0.01	0.01	0.01
50	0.73	0.46	0.36	0.3	0.23	0.18	0.15	0.12	0.09	0.06	0.05
75	...	1.54	1.23	1.02	0.77	0.61	0.49	0.41	0.31	0.21	0.15
100	...	...	...	...	...	1.46	1.16	0.97	0.73	0.48	0.36
125	...	...	...	...	...	...	. .	...	1.42	0.95	0.71
150	...	...	...	...	...	...	...	...	...	...	1.23

T′ and T″ it is equal to $\frac{s}{2}$ which is its maximum value. Hence, by reducing the radius slightly (r'' being only a little less than r), a spiral may be introduced without moving the track by any very large amount. Since the reduction in the radius is small, the same Tables may be used without causing any great error.

The curve may best be set out as follows. Having determined the spiral number n to be used, look up in the tables (table I) the amount of the shift s and then calculate the new radius r'' from equations (1) and (2). The new tangent will be

$$t'' = r'' \tan \alpha.$$

Set out a new straight parallel to the old straight and at a distance s from it, and shift the tangent-point a distance $t - t''$, or $(r - r'') \tan \alpha$, from the old tangent-point T; from the new tangent-point T″, set out a curve of radius r''. Then set out the spiral by offsets from the straight (table II).

It may be considered that the method is complicated; but when the curve is set out afresh and the tangent-points, if not known, are found, it may be completed by the use of a few simple calculations. Objections may be raised to the increase of curvature; but the increase is small; it may only be 1 or 2 % and certainly need not exceed 10 %. A comparison of the two methods when applied to a practical case is shown in figure 2. It will be found that, if the curvature of any railway curve be checked by measuring a few versines, the radius varies far more than 10 % on either side of the correct radius. It is, in fact, impossible to lay out and keep a curve so accurate that the variation is less than 5 %.

In order to keep the spiral in shape, permanent pillars should be built, showing the position of the two ends and of the middle point, which will be found quite sufficient for all practical purposes. These pillars also show where the superelevation begins and where it reaches the full amount, and thus prevent the practice of superelevating the rails on the straight.

This method of applying a spiral to an existing curve can, of course, be used for other spiral curves, the railway transition spiral for instance; but as the cubic parabola coincides with this spiral within certain limits and is simpler to understand, it is preferable.

On hill railways, where the curves are sharp, transition curves can easily be introduced by this method on account of the small shift required.

No difficulty has been experienced in getting Indian surveyors to use the method.

The Paper is accompanied by five drawings, from some of which the figures in the text have been prepared.

[621 .133.7]

Design and performance of locomotive feed water purifiers on Hungarian State Railways,

From Desider Ledacs KISS,
MECHANICAL ENGINEER.

Figs. 1 to 3 pp. 999 to 1001.

(*Railway Review.*)

In all except the central European countries, the very effective and practical method of purification by means of a purifying device mounted upon the locomotive boiler, seems to have been universally overlooked. The most extensive and practical application of this method of feed water purification has been accomplished by the Hungarian State Railways. This system is spread over all of the territory that was formerly Hungary and embraces a wide variety of locomotive feed water conditions. For example, on the Budapest-Fiume line the feed water is of such a character as to necessitate very frequent cleaning of the boilers, under which condition copper fireboxes require renewal after two or three years, while ingot iron fireboxes which were tried in this service lasted only a few months. On the Transylvanian section of these lines, however, water conditions are such that the usual life of fireboxes ranges from ten to fifteen years.

The quantity of dissolved salts in water which produce scale by evaporation can only be determined by chemical analysis. The quantity of dissolved salts and the degree of hardness determine the chemicals necessary to precipitate the dissolved salts. The desirability of treating all feed water before delivery to the locomotive is recognized but the cost of equipping and operating treating plants at all water stations is prohibitory and is only justified at those stations where the water is very hard and where a considerable quantity of water is required. For this reason the Hungarian State Railways have found it more practical to place small feed water purifiers on the locomotives. Moreover, these purifiers, as described in the following, also serve to equalize the temperatures of the feed water and boiler water which is a particularly advantageous point with respect to boiler maintenance since the injection of cold water tends to set up severe strains throughout the boiler. Where iron or steel fireboxes are used, this lengthens the life of the firebox considerably. The application of feed water purifiers also has an advantage over the use of chemicals in the locomotive boiler since it is never possible to proportion these exactly to the quantity of impurities in the feed water. This usually results in a surplus of the chemical being used at unnecessary expense to the railroad. The use of chemicals is, in itself, objectionable since it causes the injurious salts to be precipitated in the form of a sludge which accumulates along the bottom of the boiler unless frequently blown out through the blow-off valve. Moreover, the introduction of chemicals within the locomotive boiler gives rise to a foaming tendency unless specially counteracted. Crude oil has also been used to break up and prevent scale on the boiler tubes

and firebox. In Germany recent experiments have led to very good results through the precipitation of salts in the locomotive by the introduction of carbonic acid into the feed water. This method has proved particularly effective in certain kinds of feed water.

Mechanical feed water purifiers, however, obviate the disadvantages of chemical treatment within the locomotive boiler, by subjecting the feed water to the full heat and pressure of the boiler before it actually enters the boiler. Simultaneous to the application of heat and pressure, the velocity of the feed water is reduced so that it is possible for the precipitated salts to form a sediment within the feed water purifier. The high pressure within the purifier causes the greater part of the solid components to deposit in a pulpy form, while the portion carried over into the boiler forms a sediment which can be blown off easily. Mechanical feed water purifiers of the type under consideration enjoy a further advantage in respect to operating and maintenance costs since they require no attention while in service and it has been found that they can, if necessary, be run for more than a year without being cleaned as was recently demonstrated by some locomotives delivered to the Jugo-Slavia and subsequently returned to the shops of the Hungarian State Railways for repairs.

Purification of locomotive feed water by means of a simple and efficient apparatus attached to the locomotive presents so many advantages from an operating and first cost standpoint that the Hungarian State Railways have, in recent years, undertaken some extensive development work along this line with the result that several thousand locomotives are now equipped with devices of this character. The type most generally used is known as the Pecz-Rejto feed water purifier and there are now about 3 000 locomotives equipped with this device on the Hungarian State Railways. The success obtained with the use of feed water purifiers on the State Railways has recently inspired some further development along this line by other Hungarian railways so that there are now two other designs in use known as the Pogany and Rauscher systems. These systems have been adopted in Austria to some extent and some recent development work along this line has recently been accomplished both in England and Germany. The new standard 2-10-0 type freight locomotives recently constructed in Germany are equipped with a modified form of feed water purifying apparatus as illustrated on page 38 of the 6 January 1923 issue of the *Railway Review*.

The Pecz-Rejto feed water purifiers were first applied to locomotives of the Hungarian State Railways in 1910 and since 1912 every new locomotive constructed for these lines was equipped with a feed water purifier of this type. As will be noted from the accompanying drawing (fig. 1), the Pecz-Rejto device comprises a cylindrical steam box mounted on the barrel of the boiler in which a series of cells are mounted in such a manner that they can be withdrawn as a unit by removing the head of the steam box. The number of cells ranges from 4 to 12 according to the steam generating capacity of the boiler, an even number of cells always being used, however. Where 4 cells are installed, it is customary to mount the steam drum at right angles to the boiler as on the smaller and older locomotives to which this device was first applied experimentally. Where 6, 8, 10 or 12 cells are employed, the feed water purifier is always mounted parallel to the axis of the boiler, as shown in the accompanying view.

To obtain the best results from the operation of these feed water purifiers a slow rate of boiler feed is required in order to give the solids time to precipitate in the purifier cells. Referring to

the accompanying diagram of this device, it will be seen that the feed water enters the purifier through the check valve at the top of the steam drum.

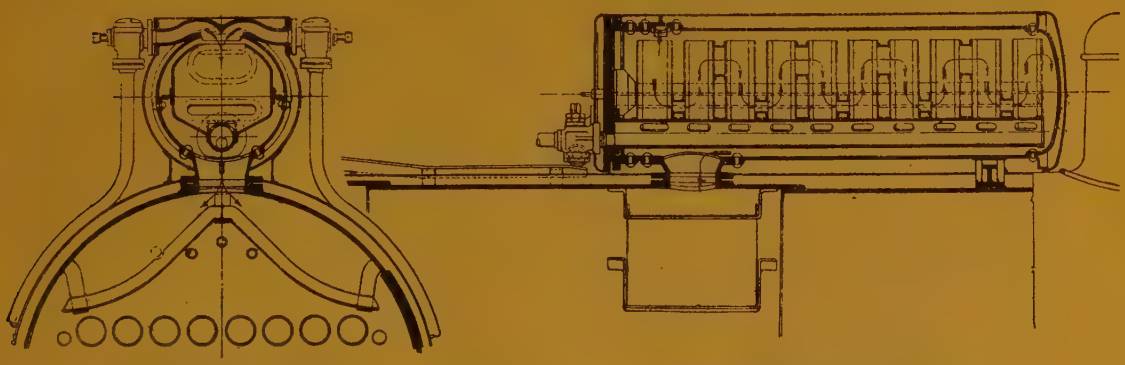

Fig. 1. — Typical 10-cell, single drum Pecz-Rejto type feed water purifier as applied to Hungarian State Railway locomotives of recent construction.

Within the purifier the feed water is subjected to full boiler pressure and the temperature of the steam at this pressure. Passing through the cells in the direction indicated by the arrows, the feed water flows down into the boiler through the main connection between the steam drum of the purifier and the barrel of the boiler. The scale precipitated during this operation collects in the longitudinal mud reservoir upon which the cells are mounted. From this mud reservoir, the solids precipitated in the form of loose sediment can be blown out at intervals through a blow off valve while solids deposited in the form of scale upon the walls of the cells can be removed by taking the cells out of the purifier and cleaning them at intervals.

A deflector plate placed immediately below the opening from the purifier into the boiler, branches to either side of the tubes, serving to deflect the feed water to the sides of the boiler shell and prevent any solids that may be carried through the purifier from falling directly on the tubes. This also tends to direct any unprecipitated solids toward the bottom of the boiler from where they can be discharged through a blow off valve. Some hard scale also accumulates upon this deflector plate from which it can be removed whenever the boiler tubes are renewed. The Railway Managing Board in Hungary have laid down the rule that both the boiler and feed water purifier must be blown off at intervals of from 125 to 250 miles operation. For this purpose, blow off valves are positioned in the throat sheet and at the bottom of the boiler shell near the front tube sheet. Instructions for the operation of the feed water purifier stipulate that in blowing off this device, the blow off valve shall be opened twice, allowing a sufficient interval between these openings for the purifier cells to fill with water, this being necessary to prevent the accumulated scale from burning to the walls of the cells.

It has been demonstrated on the Hungarian State Railways that locomotives provided with feed water purifiers of the type under consideration will make many times the mileage without boiler washing than is possible for locomotives not equipped with this device. This conclusion is based upon a series of ob-

servations, the results of which showed that an express locomotive operating without a purifier requires boiler washing after running from 220 to 665 miles, while a similar locomotive equipped with a feed water purifier can be safely and economically run from 2 050 to 10 000 miles without boiler washing. From the standpoint of time in service, it appears that locomotives with feed water purifiers are operated in Hungary for periods of from one to three months without boiler washing, while without feed water purifiers, these boilers must be washed, every few days. In freight service, locomotives with feed water purifiers are run from 2 800 to 4 350 miles without boiler washing when the absence of a feed water purifier necessitates boiler washing within 250 to 450 miles. There are approximately 3 000 locomotive water purifiers of the Pecz-Rejto type now in service on the Hungarian State Railways. These purifiers are easily cleaned by unbolting the head. Two rails mounted on the boiler and the small wheels attached to the head of the drum facilitate the withdrawel of the cells for cleaning.

The Pogany system is a later develop-

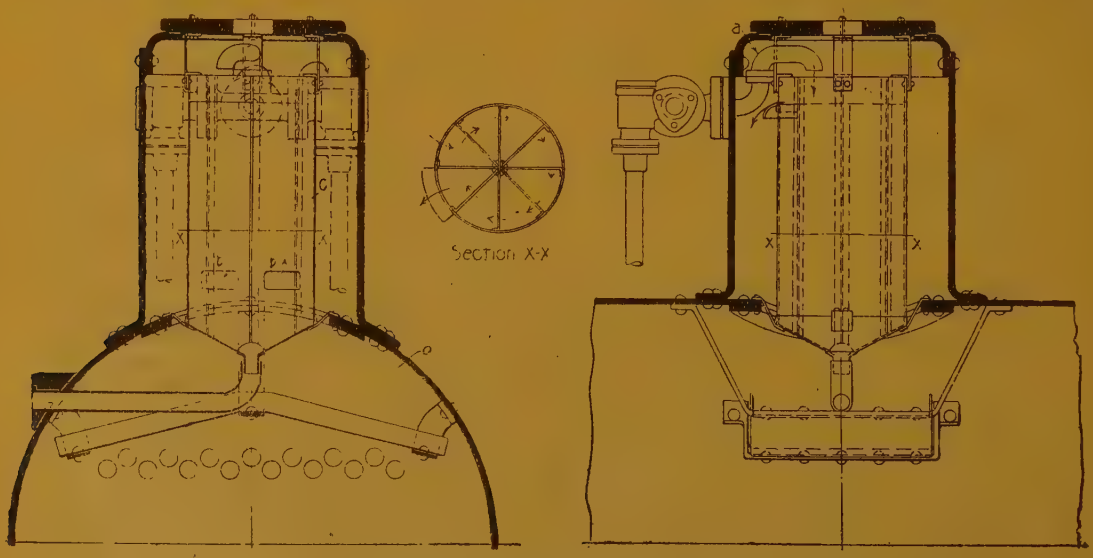

Fig. 2. — Details of the Pogany type of locomotive feed water purifier as recently developed on the Southern Railway of Hungary.

ment in locomotive feed water purifiers which has found extensive application on the lines of the Southern Railway of Hungary and has also been used to some extent in Austria. In feed water purifiers of this type, as shown in the accompanying drawing (fig. 2), the feed water enters a special dome, back of the main steam dome, in which is located the feed water purifier, a cylindrical device with a number of vertical partitions dividing the apparatus into a number of cells. The feed water is first directed into the compartment I, from which it flows to the compartment II, thence to compartment III, and so on, around the cylinder to compartment VI, from where it flows into the narrow segment of the cylinder designated as C. In its course through the purifier, the feed water al-

ternately flows down and up in adjacent compartments as determined by the apertures *b*, at the base of the partitions between I and II, III and IV, V and VI. The feed water is required to pass over the top of the other partitions and into the compartment C. From C, the feed water flows down onto the deflector plates that divert any solid impurities from the tubes and direct the feed water against the sides of the boiler shell.

Precipitation of the solid impurities occurs as in other feed water purifier previously described. These impurities can be discharged through a connection at the base of the apparatus leading to the side of the boiler shell on the outside of which a blow-off valve is attached. As will be noted from the accompanying drawing showing the application of this device, the apparatus is attached to the cover plate of the special dome so that removal of this cover plate enables the removal of all the cells as a unit for the purpose of cleaning them whenever this is necessary.

While the Pogany feed water purifier serves to lengthen the interval between boiler washings to several times the period that locomotives can be operated without a purifier, the Pogany system of feed water purifiers is not so effective as those designed in accordance with the Pecz-Rejto system due principally to the fact that the heating surface with which the steam comes in contact is not as great in the Pogany purifier as in the Pecz-Rejto design. As a result, the feed water is not heated to as high a temperature in the Pogany device. The Pecz-Rejto feed water purifier has another advantage in that its capacity can be more easily enlarged since the size of the dome required for the Pogany purifier tends to limit its capacity. The Rauscher system of feed water purifiers as recently applied to locomotives on the Southern Railway of Hungary and the Kassa-Oderberg Railway (fig. 3) is the latest development in this field. In this design, the feed water flows over a series of stepped deflector plates, presenting a much greater heating surface exposed to the steam than in the Pogany purifier. The Rauscher system is also an improvement over the Pogany design from a structural standpoint. Impurities deposited in the form of sediment can be discharged through a blow-off valve and scale deposited on the plates can be cleaned by removing the apparatus through the dome cover.

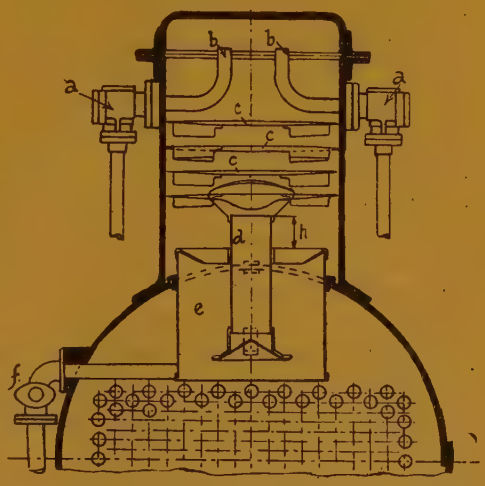

Fig. 3. — Sketch showing general construction of the Rauscher type of locomotive feed water purifier which comprises a number of stepped plates over which the feed water flows in contact with the steam before entering the boiler.

In summing up the advantages of mechanical feed water purifiers as applied to Hungarian motive power, it may be said that the frequency of boiler washings has been greatly reduced through their use. This not only prolongs the life of the boiler but saves a large amount in the cost of locomotive maintenance and reduces the length of time locomotives must be held out of service for this maintenance work. This is equivalent to reducing the number of locomotives required to render a

certain service. With a reduction in scale accumulations within the boiler there is a direct saving in fuel consumption in operation while a reduction in the number of boiler washings required leads to a considerable fuel saving. The preheating of the feed water to a temperature approximating the temperature of the steam in the boiler has a favorable effect upon the performance and maintenance of the locomotive, although the saving resulting from this method of feed water heating should not be confused with the gain in efficiency accomplished by utilizing a portion of the exhaust steam to heat the feed water as in various types of feed water heaters now on the market. Perhaps the best testimonial that can be offered as to the effectiveness of the feed water purifiers developed in Hungary is found in the recent adoption of this device as a standard for Roumanian motive power following the seizure of several thousand Hungarian locomotives by the Roumanians in 1919. These locomotives were equipped with the Pecz-Rejto feed water purifiers, with which the Roumanians were unfamiliar up to that time. This, however, enabled them to compare the results of operating a large number of locomotives with and without feed water purifiers. The superior performance of locomotives equipped with mechanical means for purifying the feed water soon led to the general adoption of feed water purifiers by the Roumanian Railways. Wherever the results of this method of feed water purification have been thoroughly investigated as in Austria and Germany, an extension of this system has been favorably considered.

[621 .133.7 (.436)]

Gas type feed water heaters on Austrian railways.

By John RIHOSEK,
MECHANICAL ENGINEER.

Figs. 1 and 2, pp. 1004 and 1005.

(From the *Railway Review*.)

The Austrian National Railways now have seven locomotives equipped with a new type of feed water heaters of the waste gas type. One of these is a *Consolidation* type freight locomotive and the other six locomotives thus equipped are of the *Decapod* type. The design of feed water heater applied to these locomotives is illustrated in the figure 1, from which it will be seen that this consists principally of straight tubes between headers located in opposite walls of the smoke box. This arrangement provides for a large tubular surface area extending across the path of the waste gases. The flow of gases through feed water heater is controlled by means of dampers so that all or only a portion of these gases, as may be desired, pass over the water tubes. The feed water heater is inserted as a unit in the locomotive smoke box, resting in slots in the smoke box walls, from which it can be withdrawn by removal of the front end, as shown in the figure 2. The cover plates over both headers, however, may be taken off without removing the heater from the locomotive.

As applied to locomotives of the Austrian National Railways the feed water heater described in this article receives water from an injector. This is regarded as a great advantage since the economies resulting from the operation of these heaters are obtained without necessitating the substitution of a steam pump for the usual injectors. Not only the first cost of the steam pump is thus eliminated but the additional weight and maintenance cost of the pump is avoided. To obtain the greatest economy with any feed water heating apparatus it is nec ssary to maintain as nearly a constant flow of water as possible while the locomotive is working steam. In order to obtain uninterrupted operation with an injector, as in feed water pumps, the Friedmann Company, who are the principal manufacturers of injectors in this country, designed a new style of double injector for use on the Austrian National Railway locomotives equipped with waste gas feed water heaters. This apparatus consists of a double injector with one 6 millimetre (0.236 inch) nozzle and one 8 millimetre (0.315 inch) nozzle. Both nozzles are incorporated in the same housing with single steam, suction and delivery tubes. With this injector it is possible to adjust the delivery of water so as to maintain an uninterrupted flow irrespective of rate of evaporation in the boiler. Ordinarily the 6 millimetre nozzle is sufficient to meet the requirements of the locomotives if supplemented occasionally by the 8 millimetre nozzle.

Reference has been made to the structure of this feed water heater, which is designed to facilitate cleaning both the interior and exterior surfaces. This is a very vital matter since the efficiency of a feed water heater of the waste gas type is entirely depended upon keeping the interior surfaces free from scale and the exterior surfaces free from soot. In addition to providing for the removal of the cover plates which give access to either end of the straight tubes, the apparatus is designed to facilitate cleaning by means of blowing out at the end of each run. For this purpose blow-off outlets are provided so that before and after every trip these can be opened and heater blown out by the operation of both nozzles of the injector. This serves to remove any accumulation of mud and soft scale. So far, this has been found to be a very satisfactory means for removing accumulated mud and muddy incrustation. Where a hard scale is deposited on the interior of the heater the removal of the cover plates provides access to either both ends of the tubes so that these can be mechanically cleaned. There is also the alternative of using a dilute acid solution for maintaining the interior of the tubes in a clean condition without removal of the cover plates. As soot is deposited in the exterior surfaces of these tubes, a blower device is provided for the removal of this soot. This comprises a number of vertical perforated tubes between each bank of preheater tubes and connected to a live steam valve in the locomotive cab. The perforations in these tubes act as nozzles for live steam, which blows the soot off the tubes when the valve in the cab is open for a few seconds.

The first feed water heater of this type was designed with four header chambers and at a total heat absorbing surface of about 334 square feet. With this arrangement the feed water was required to make four passes through the heater before entering the boiler. The initial performance of this preheater proved very satisfactory and tests demonstrated that it served to raise the feed water to a temperature of approximately 212° Fahr. However, after this apparatus had been in service for a period of three months a number of small leaks developed from slight fissures at the circumference of the tubes. Moreover, these tubes, which were of brass, developed some bends which in-

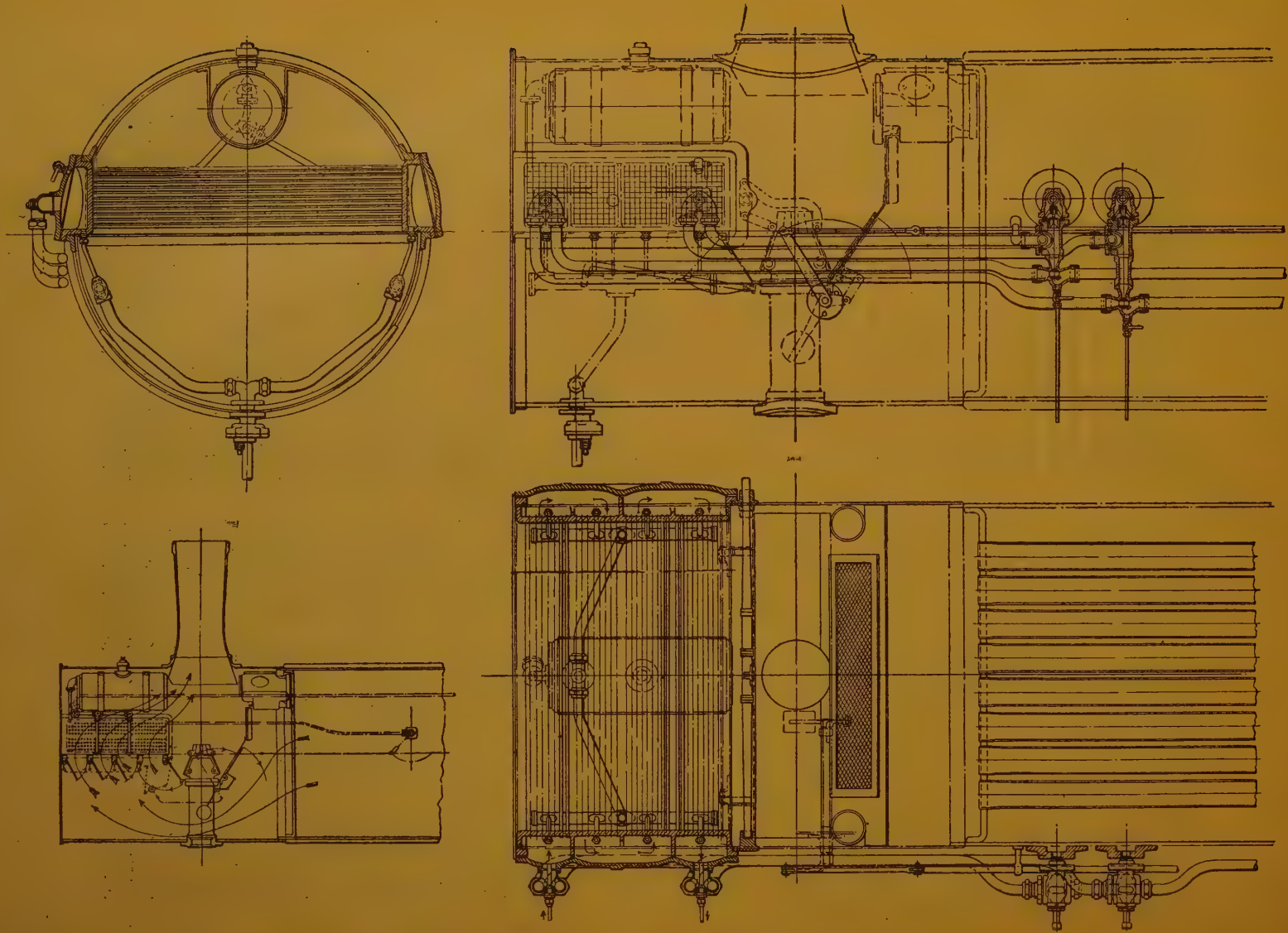

Fig. 1. — The principal details and general arrangement of the Rihosek waste gas type feed water heater as applied to locomotives of the Austrian National Railways are shown in these drawings.

dicated that the annealing process must have taken place. It was discovered that in some instances the locomotive had been operated without any water in the tubes of the preheater. To prevent a recurrence of conditions that would cause the tubes to become overheated when they were not filled with water, dampers were placed below the preheater tubes. The operating mechanism controlling these levers was also connected to dampers on either side of the exhaust stand so that if the dampers below the preheater tubes were closed, the dampers on either side of the exhaust stand would be opened simultaneously. With this arrangement, it will be seen that all of the waste gases can be forced to pass over the tubes of the preheater or if feed water is not flowing through the preheater tubes while the locomotive is working steam, the course of the waste gases can be directed up the stack without coming in contact with the feed water heater.

As a further protection against the preheater tubes burning out when the injector is not in operation, there is a direct connection between the preheater and the boiler through a valve which is opened by means of interlocking levers when the dampers below the preheater tubes are closed. This valve provides for a small flow of water from the boiler back into the preheater. This valve is, of course, closed and the dampers in the smoke box adjusted so that the hot waste gases pass over the preheater tubes whenever the injector is in operation. To provide an additional safeguard against the preheater tubes running dry, a reservoir consisting of a large drum is located immediately above the preheater tube and connected to these. In addition to acting as a reservoir for the preheater, this drum serves to divert a portion of the hot waste gases to either end of the preheater tubes.

In the present design of this feed water heater, the headers have six chambers, so that the feed water is required to make six passes through the preheater tubes. These tubes, which are also of brass, are 17 millimetres in diameter instead of 15 millimetres, which was the diameter of tubes used in the original feed water heater of this type. The thickness of these tubes was also increased from one millemetre to one and one-half millimetres and these brass tubes were subject to very rigid specifications so that no serious difficulty has since been encountered owing to the failure of these tubes. The larger tubes employed in the more recent preheaters, together with some increase in the spacing of these tubes, has resulted in decreasing the heat absorbing surface of this apparatus to 247.5 square feet.

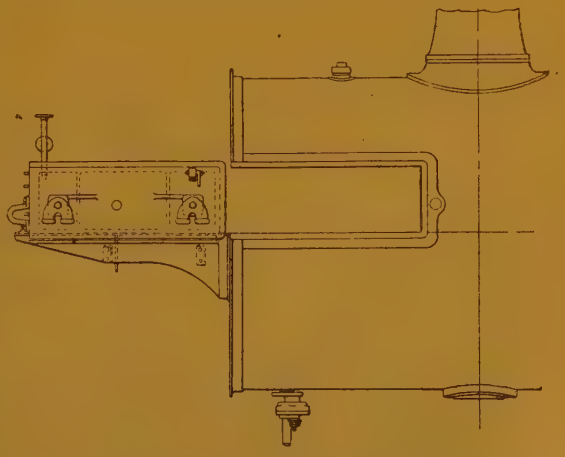

Fig. 2. — The Rihosek waste gas type feed water heater can be inserted as a unit or removed from the locomotive smoke box as shown in this sketch.

To demonstrate the efficiency of this waste gas type of feed water heater, a number of test runs were made on the same locomotive under as nearly identical operating conditions as possible but with and without the feed water heater in service. Observations of conditions in the smoke box included a record of the vacuum and temperature of

the exhaust gases before and after passing over the preheater tubes. The performance of the preheater itself was noted in the temperature of the feed water recorded before and after passing through this apparatus.

It has been recorded that the temperature of the waste gases is reduced to the extent of from 200 to nearly 300° Fahr. in passing over the preheater tubes and that the temperature of the feed water passing through these tubes is increased from an injector delivery temperature of 120° Fahr. to an average temperature of over 200° Fahr.

The vacuum in the smoke box varied from 2 inches of water the speed being 25 miles per hour with 20 % cut-off and a 12 % throttle opening to 4 inches the speed being 12 miles per hour with a 40 % cut-off and a 42 % throttle opening.

The saving in fuel resulting from the operation of the feed water heater ranges from approximately 12 to nearly 20 %, depending upon the output of the locomotive; the greatest saving resulting when the locomotive is being operated at its maximum capacity. These tests have demonstrated that locomotive boiler efficiency can be greatly increased by an apparatus designed to raise the temperature of the feed water by reclaiming heat from the waste gases of combustion. Moreover, the operation of the locomotive is further improved by reducing the temperature and hence the volume of gases exhausted from the stack.

[656 .211.4]

Principles of terminal station design,

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(*Railway Age.*)

A passenger terminal improvement represents perhaps the largest single expenditure the railroad makes for an individual improvement, and the degree of skill with which it is planned to a great extent predetermines its future as an asset or a liability.

The preliminary examination must determine that the project satisfies the following conditions :

1. — That the improvement at the proposed site is desirable from the viewpoints of construction and operating costs and has advantages equal or superior in these respects to the results which can be secured at any other available location.

2. — That suitable development can be made in stages to meet the expected normal growth in the services involved for a sufficient term of years to justify the project.

3. — That the proposed improvement is desirable from the viewpoint of the municipality and in harmony with its plans for development.

4. — That the advantages offered to the public are sufficient to justify such concessions as may be required from the municipality.

5. — That the project in its entirety presents a sufficiently favorable economic aspect, free from insurmountable

prior obligations, to insure its complete, rational financing.

6. — That the by-products of the development such as the overhead or air rights can be utilized in a practical and profitable way so as to absorb, or at least substantially reduce, the carrying charges of the improvement.

7. — That the project as planned is so sound and free from imposing burdensome conditions upon the railroad, that controlling or governing bodies will readily approve same.

8. — That the cost of the station facilities per car unit and their operation will not be excessive in comparison with that of other sites. This is particularly important for locations so restricted in area that double-deck structures may be necessary to secure required capacity.

9. — That the improvement is of such type that adequate enhancement of land values within the terminal area will necessarily follow.

Specific requirements.

The foregoing broad principles being satisfied, the basic idea must be in harmony with the following :

Except at new locations, the plan must, in its general conformation, fit in with existing conditions to a sufficient extent to permit of gradual transition into the complete or final plan without serious disturbance of operation, and in such stages as will conform with the development of railroad traffic and contiguous property. Obvious economic and practical reasons make this imperative.

It must strike a proper balance between the public comfort and convenience on the one side, and economy in both first cost and subsequent operation on the other. This insures good will on the part of the public, and efficient and liberal service on the part of the railroad.

The general layout must be orderly and direct in the placement of its principal parts, because in a project of large dimensions and scope, freedom from disorder and confusion is in direct proportion to the simplicity of the plan.

The railroad facilities provided must co-ordinate with the complete development of streets and blocks throughout the terminal conforming with the civic plans for unrestricted expansion of the city adjacent to or across the terminal area. This will benefit both the railroad and the public.

Facility of adjustment to future requirements must be arranged for, because the useful life of railroad facilities is limited by obsolescence rather than by physical decay. Such facilities, therefore, can be considered stable or permanent only insofar as they are adjustable to changing conditions. This applies with special force to terminals which must, in their initial stages, be operated by steam.

Definite determination must be made of the adequacy of approaches, throats and yards, to assure ample capacities of trackage, all in proper balance, thereby making possible a high degree of operating effectiveness.

Selection of characteristic basic types.

After the plan has been proven to be in accord with the preceding requirements, determination must be made of certain characteristic basic types, as follows : *a*) Through or stub type, as affecting train operation, and *b*) headhouse type, as affecting station operation.

The through type is concededly best adapted for efficient and rapid train handling, and is, therefore, where choice can be made, the type to be selected unless a careful investigation of all the elements affecting the correlated and dependent facilities, fails to disclose the

necessary preponderance of factors in its favor.

The stub type can, where the conditions permit, be given some of the special advantages of the through type of providing a loop or engine release arrangement. In the stub type of terminal, except in cases where there is a difference between street and track level, the platforms and other facilities can be arranged at one level. This results in advantages as follows : 1° Highest total efficiency in operation and the greatest convenience to the public; 2° freer and faster travel on platforms, unencumbered by stairs or ramps; 3° practical elimination of vertical travel of passengers between streets and platforms; 4° economy in construction cost, maintenance, and operation. The short haul (suburban) traffic with its intensive service requirements should, wherever possible, be provided with means for through or continuous train operation.

A definite selection must be made of one of the three general types of head-house before proceeding with the consideration of the arrangements of the detail features :

1. — Waiting room type of head-house, where the waiting room is made the focal center of the station, with all dependent facilities such as ticket office, baggage and check rooms opening directly therefrom and with separate passenger concourse for access to train platforms. The Washington Union Station is an example. (This arrangement tends to make the main waiting room a thoroughfare between the street and the trains.)

2. — Concourse type of head-house, where a large general passenger concourse is provided for the mass movement of passengers, with ticket office and other dependent facilities opening directly therefrom, the waiting room with its auxiliary facilities being placed adjacent to but separate from the concourse. The Grand Central Terminal, New York City, is an example. (This type tends to minimize conflict of foot passenger traffic.)

3. — Composite type of head-house, where a large room is provided exclusively for the sale of tickets, checking baggage and like dependencies, with separate waiting rooms and passenger concourse. The Pennsylvania Station, New York City, is an example. (This type tends to create cross-currents of travel between the various station facilities.)

Traffic considerations.

Although station facilities should be planned to accommodate anticipated traffic, it is not essential to provide for extreme peak conditions, because, in a well planned station, an overload can be carried by all facilities for occasional periods without undue operating stress or inconvenience to the public.

The general arrangement should invite movement of foot traffic along natural and direct channels so that passengers may, as far as practicable, avoid crossing the main travel routes and the retracing of steps. Where established lines of city foot traffic are permanently interrupted by the terminal construction, provision should be made to accommodate this traffic without interfering with the normal use of the station.

The separation of suburban and through traffic should be effectively accomplished in order to avoid confusion and expedite the movement of both classes of traffic. It is not essential that entirely separate concourse, waiting room and general facilities be provided. It is necessary, however, that the main channels of circulation be completely separated.

Although it is desirable to separate the passenger foot traffic channels and allocate sections of the terminal facilities to inbound and outbound traffic, no

physical division should be planned in the track layout that will limit interchangeability and elasticity.

The baggage facilities for receiving, delivery and storage should be separated. Trucking subways, bridges and other passageways may be used in common.

Adequate provision should be made for the public and private vehicular traffic in suitable relationship to station facilities.

In addition to access to streets, convenient entrances and exits should be provided for interchange of passengers with surface car lines or other local transportation systems.

The plan should provide for direct contact with all natural points of entrance and exit rather than force the diversion of traffic to points dictated purely by the necessities of the architectural composition.

Provision should be made for direct traffic contact with the passenger platforms. Where this traffic is in solid trains, consideration should be given to its location outside the terminal.

Where the terminal plan includes provision for freight traffic, this portion of the layout should be entirely segregated from the passenger facilities and, as far as possible, all freight driveways should be separate from the main streets or thoroughfares, in order to minimize the interference in the operation of these facilities with passenger and public traffic.

Station facilities.

The various facilities comprising the station proper must be placed in the natural and orderly grouping which their logical related uses dictate. The individual sizes of adjacent facilities should permit modification, if future requirements so dictate, without seriously disarranging the general co-ordination of the plan.

The passenger concourse should be roomy and entirely enclosed with weather-tight gates at the train platforms. These train gates should preferably be in a continuous line on one side of the concourse. The concourse should be free from confusing changes in direction; ample and direct access should be provided from the concourse to strategic street points and the various station facilities.

The waiting room should be arranged to be conveniently accessible for patrons from the street and station facilities without inviting usage as a thoroughfare, with all facilities for the comfort and accommodation of waiting passengers located adjacent and readily accessible. The location should permit of adequate ventilation and daylighting.

The ticket office and checking facilities should be placed in contact with, but not encroaching upon the main routes of travel between streets and trains, so that persons not requiring these facilities may pass without conflict with passengers buying tickets or checking baggage.

All working facilities should be provided with conveniences and equipment required to insure the full working efficiency and comfort of the employees.

Revenue-producing facilities conducive to the comfort and convenience of the passengers should be located along the main arteries of travel, placed so as not to reduce the effectiveness of station operation. Their arrangement should insure maximum patronage from the general public and railroad patrons, thereby enhancing their rental value.

The elaboration of the architectural features of the design should reasonably express the purpose of the improvement and emphasize the relative importance of entrances, exits and like features. Attention should be paid to mass effect which attracts the notice of the general public rather than to details which are seen or appreciated only by a few. Economical consideration should be a

definite aim throughout including the avoidance of especially elaborate constructional detail.

The station plan should impose on the office building no limitations which will exclude any essentials needed to assure successful competition with similar commercial buildings.

Where the character of overhead buildings can be predetermined, as requiring contact with the station, freight or other facilities, it should be provided for : Otherwise flexibility should be given, making possible future conversion to suit the requirements.

Platforms and ramps.

Platforms should be level with the car floor especially for suburban service. If conditions compel the use of low platforms, provision should be made for future conversion to the high type.

Where the width of platform is restricted by the need for intensive development of the property, the minimum should permit passengers to pass freely between loaded baggage trucks when placed along eitheir side of the platform.

Means should be provided to avoid trucking across platforms and tracks.

Baggage elevators should not be located in narrow platforms except at the outer end. When placed at the concourse end they should not obstruct circulation. The enlargement of platforms at the concourse end known as the « Midway » provides space for the location of elevators, stairs, and similar facilities without encroachment upon the concourse or interference with public circulation, and permits the use of several train gates at one time in speeding the exit of arriving passengers.

Separate baggage platforms are not ordinarily necessary. The handling of baggage on passenger platforms causes slight interference with passenger traffic. Suburban trains carry practically no baggage. Inbound long-distance trains normally occupy the platforms for a considerable period beyond the short interval required to discharge the passengers. Passengers for outbound long-distance trains are so thinly distributed that no appreciable interference results. However, if such platforms are provided at all, they should be of ample width, as narrow ones will be useless.

The spacing of platforms and tracks, particularly if lines of columns are necessary, should be designed to permit ready rearrangement of platform widths to meet future needs.

Column lines for superimposed structures in the absence of controlling conditions to the contrary, should be located in the platforms instead of between tracks thereby reducing danger to overhead structures, increasing the view for operation, adding to safety and facilitating maintenance. Columns in platforms interfere but slightly with passenger movement, with small loss of space, whereas, when between tracks, the space is entirely lost.

Where the tracks and streets are necessarily at different levels, the vertical travel, if possible, should be by means of ramps, rather than by stairways. In general, ramps permit more rapid circulation, cause less fatigue and minimize accidents. Where the foot of ramp extends several car lengths or more from the station end of a narrow platform, provision should be made to avoid backward travel of arriving passengers.

Track facilities.

A reasonable proportion only of the station tracks need be of sufficient length to accommodate the longest trains that present power can handle, plus an allowance for increase.

Excessive rates of curvature and grades should be avoided as interfering with effective and safe operation; and tracks along platforms, especially of the

high type, should as far as possible, be straight. Where overhead building construction is contemplated, the track spacing and location of special work should afford reasonably free opportunity for placing of columns and avoidance of long building spans. Where conversion from steam to electric power in the future is a possibility, provision should be made to permit the installation of electrical features affecting the track and platforms.

In addition to the usual provisions for changes due to temperature, all buildings the rental value or use of which is adversely affected by excessive vibration should, as to their foundations and other structural parts, be entirely separated from similar parts in other buildings or structures through which directly or indirectly the vibration due to rolling or live load may be transmitted. Columns at track level where necessary should be protected by suitable collision piers to prevent failure through derailment, and should never be located in the direct line of the track immediately beyond a bumping post. The choice of type of future electrification, if initial operation is by steam, should not be hampered by any structural limitations, such as insufficient headroom.

Provision should be made for the location of all auxiliary operating facilities such as signaling, central plants, substations and equipment, entirely separate from the station facilities wherever possible but accessible to same. In determining the proper location, due weight should be given to the influence of all economic elements such as land values, economy in handling supplies and waste material, and load distribution.

Averages and statistics derived from other terminals, while interesting and helpful, have no final determining value. The facts of record at the terminal under consideration must finally govern. Each facility must be tested by the actual local requirements. Consequently when the general design has been accomplished, it is imperative that the final test as to load co-ordination be applied to determine : That all parts are in balance; that no individual feature is under or over developed; and that all features will simultaneously reach the saturation point.

To accomplish this, an analysis should be made of the operating capacity of the approach tracks, throat tracks, and body tracks, as a proper balance of these facilities is of vital importance. Likewise the relative values of practically all supporting facilities in the plan should be measured and balanced to safe-guard the successful future of the development.

As an example, the ticket office size and number of selling windows, can be definitely arrived at as they have a fixed relation to the number of outbound passengers of all classes handled which is, in turn, determined by the ultimate saturation point of the track facilities used for outbound cars.

[656 .222.4 (.75)]

Operating trains against current reduces delays,

By K. E. KELLENBERGER.

Figs. 1 to 3, pp. 1014 to 1016.

(*Railway Age.*)

The Cleveland, Cincinnati, Chicago & St. Louis is one of the few roads which uses its idle stretches of second-track for operating trains against the current of traffic. An analysis of a typical day's movements on the territory where this is done most frequently shows that 42 out of 97 passenger trains, and 21 out of 104 freight trains used the opposite main tracks for varying distances. The operation of these trains against the current of traffic prevented five trains from being tied up under the 16-hour law while the total train time between terminals was shortened 1 880 minutes. This saving in time alone, capitalized on the basis of 40 cents per minute of delay, represents a total of $752 for the day or $274 480 a year, in the territory on which the study was based.

The Big Four, with a mileage of road of 2 416 has 568.3 miles of double-rack. The principal stretches of double-track extend from Cleveland, Ohio, to Gretna, 146 miles; Cincinnati, Ohio, to Coal Springs, 74 miles; S. Louis, Mo., to Pana, Ill., 88 miles; Indianapolis, Ind., to Terre Haute, 72.2 miles, and Cincinnati, Ohio, to Greensburg, Ind., 62.8 miles.

The territories over which trains are operated against the current of traffic most extensively, are between Cleveland, Ohio, and Bellefontaine, 140.7 miles; Cincinnati, Ohio, and Springfield, 79.3 miles; Indianapolis, Ind., and Terre Haute, 71.6 miles; Pana, Ill., and Lenox, 70.6 miles, and between Cincinnati, Ohio, and Greensburg, Ind., 62.8 miles. For the purpose of this analysis the districts from Pana to Lenox; Cleveland to Bellefontaine, and Springfield to Cincinnati were studied. Automatic signals are in service over all or part of the last two mentioned territories while the first mentioned territory is operated under the manual block system.

Trains were first operated against traffic as a regular, instead of an emergency, method of procedure on the Cleveland division some time before 1900 and on the St. Louis division in 1900. For the purpose of operating trains in this manner, the double tracks in manual block territory have been signaled as two single tracks by the erection of high signals for both directions. This work was started in 1904. In automatic signal territory, automatic signals have been installed for the operation of trains in the normal direction of traffic and the manual block system has been superimposed on the automatic block system for governing train movements against the current of traffic the two tracks then being operated as single tracks between the limits where reverse movements are being made.

The greatest change or addition to the signal system required for operating trains in either direction on either track is at the interlocking plants. Here the principal change consists of the use of high signals to govern train movements at locations on the main line where dwarf signals are commonly employed. Thus each track is completely signalled

as a single track for movements in either direction. The additional cost for arranging interlocking plants in this manner is approximately $4 000 for the average plant in automatic signal territory. The smaller the plants, however, the greater is the proportionate increase in cost for signaling. This may average approximately 10 % higher than on the average plants for signaling the tracks in both directions. In manual block territory the additional cost approximates only about $2 000, which covers the mechanical equipment required and its installation.

The questions naturally asked regarding normal train operation against the current of traffic are : 1° Is the system safe and what precaution are taken to insure safety? 2° How does the system operate; what changes in rules are required and what steps are taken to divert a train from and return it to its right main? 3° What are the results?

Few rules required to insure safe operation.

The territory in which the movement of trains against the current of traffic is the rule rather than the exception includes districts with both single and double track. The train crews, in running between these terminals, handle trains daily on single and double track and are thus familiar with the rules governing both systems of operation. This thoroughly grounds them in operating requirements in double track territory when their trains are moving against the current of traffic, as in such cases rules for running on single track govern.

The different division time tables make reference to train operation against the current of traffic under the special instructions covering operations on the particular division. Typical of these instructions is that taken from the St. Louis division time table stating that :

« The automatic block system will be used for movements with the current of traffic between Kingan's (Indianapolis) and Waver. The manual block system will be used for movements against the current of traffic between Mt. Jackson and Waver. Rules 317A (1) and 331A (1) will govern when passenger trains are involved, and rules 317B (1) and 331B (1) when trains not carrying passengers are involved.

« Rules S-251 and S-254 (1) inclusive, will govern on single track, and rules D-251 and D-254 (1) inclusive, will govern with the current of traffic on double track between Kingan's (Indianapolis) and Starr, between Karl and Lenox via Short Line, and between Hillsboro and East Alton via Old Line. »

In the Cincinnati-Sandusky division time tables under the special instructions one rule states that :

« The automatic block system will be used on single track between West End and Cold Springs. The movement of trains in either direction between West End and Cold Springs will be governed by block signals whose indication will supersede time-table superiority. Signalmen will report the approach of all trains to the train dispatcher, who will instruct what signal to display. Otherwise rule 509 (2) remains in force. »

This rule has resulted in the elimination of a number of train orders daily.

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(1) Standard Code Rules.

(1) Rules S-251 to S-254 inclusive, govern the movement of trains with reference to other trains in the same direction on single track by block signals. Rules D-251 to D-245 inclusive, govern the movements of trains with the current of traffic on double track by block signals. These rules state that on portions of the road so specified on the time-table or by special instructions trains are governed by block signals, whose indications will supersede time-table superiority. The movement of trains will be supervised by the train dispatcher who will deliver instructions to signal men when required. (*Editor.*)

(2) Standard Code Rules.

How trains are diverted.

In diverting trains against the current of traffic the dispatcher puts out a « 31 » order to opposing first and second class trains at the first open station beyond the point at which the train is to be crossed back to its right main and to the operator at the station where this crossover movement is to be made. The dispatcher also puts out the same order on form « 19 » to the operators at the intermediate open stations and to the operator and the trains affected moving in the same direction at the station where the train is to be diverted to the opposite main track. Where the train to be crossed over carries passengers the order must be delivered to it one station in advance of the point of diversion. As an example, a westbound train was diverted to the eastward main at Pana, Ill., with orders to run to Nokomis. The following order was put out as a « 31 » order to all trains eastbound at Irving, to the operator at Irving and to the operator at Nokomis, while form « 19 » was used in sending it to the operator at Rosamond (the only open station) and to the operator and trains at Pana :

« No. 553 has right over opposing trains on eastward track Pana to crossover at Nokomis. »

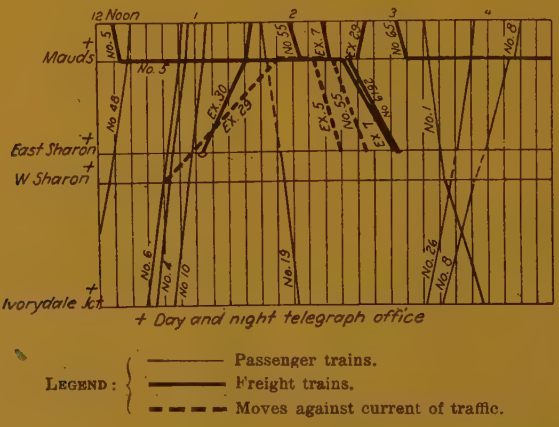


Fig. 1. — How utilization of idle main track saves delays.

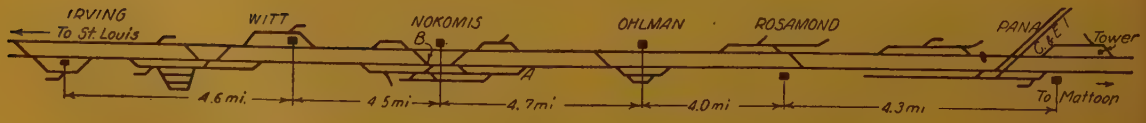


Fig. 2. — Diagram illustrating how dispatchers divert trains against current.

Typical examples of time saved.

By the addition of the word « crossover » the train has conferred on it the right to the track through the crossover back to its right main as shown at « B » on the track diagram. If the word « crossover » had been omitted from the

order the right of the train to the eastward main track would have extended only to the first passing siding switch it approached where it would have headed in as shown at « A » on the diagram. The dispatcher keeps a record of train movements against the current of traffic on his train sheet by entering in red ink the time trains pass the different stations.

A typical example of the manner in which operation against the current of traffic reduces running time and prevents delay is shown in the case of eastbound local freight No. 574 on the St. Louis division, which was diverted from the eastbound running main to the westbound main at Livingston, Ill., running against the current of traffic to Joan. This movement was made in manual block territory. If this train had not used the westbound main, which was idle at that time, after finishing its work at Livingston, it would have had to wait at Livingston for one hour and six minutes in order to permit passenger trains No. 16 and No. 522 to pass and clear the block at Joan. By this expedient, No. 574 was enabled to proceed to the next station and do its station work at that point while waiting for the passenger trains to pass.

As an example, of what is done in automatic signal territory, eastbound extra 29 (1), was run from West Sharon, Ohio, to Mauds, against the current of traffic in order to save a delay of 17 minutes at West Sharon, waiting for eastbound passenger trains No. 6, No. 4 and No. 10 to pass. Reference to the diagram will illustrate an interesting move which it was necessary to make in connection with the use of the westward main by the eastbound extra. This extra took from 12 : 40 p. m. to 1 : 50 p. m. to run from West Sharon to Mauds. Before this extra arrived at Mauds, westbound passenger train No. 19 was approaching Mauds and in order to prevent what would have amounted to a delay of 8 minutes to this passenger train waiting for the extra to get in the clear, the dispatcher diverted No. 19 to the eastward main, which was then clear, running the passenger train against the current of traffic from Mauds to East Sharon where it was diverted back to the original main. In this case two trains in opposite directions running between adjacent stations were moving on their respective contra-normal mains.

To illustrate how reversing the operation of the main tracks prevented a train from being tied up under the 16 hour law, westbound extra 6 199 left Pana, Ill., at 3 : 15 a. m., arriving at Lenox, at 9 : 16 a. m., a distance of 70.6 miles. It was in this territory that passenger train movements were made against the current of traffic, which allowed this extra to proceed on the westbound main without having to take a siding to permit three westbound passenger trains to pass. This extra was on the road 13 hours 45 minutes from East St. Louis, Ill., to Mattoon while the crew had been called 55 minutes before the train departed from East St. Louis. Westbound passenger trains No. 525 and No. 43 were operated against the current of traffic from Nokomis, Ill., to Livingston, a distance of 34.8 miles and a third passenger train No. 523, ran from Pana to Gard on the eastbound main to prevent delay to this extra 6 199 at Nokomis, which would have been incurred to allow these three passenger trains to clear the block (manual block territory) at Irving. Had extra 6 199 been delayed this additional time, it would have exceeded the 16 hour limit. The diagram shows the train movements involved.

The saving in time between terminals is of course largely to the freight trains. Between Springfield, Ohio and Cincinnati, a distance of 79.3 miles, there were

(1) Arbitrary number assigned as engine number was not recorded in this study. (*Editor.*)

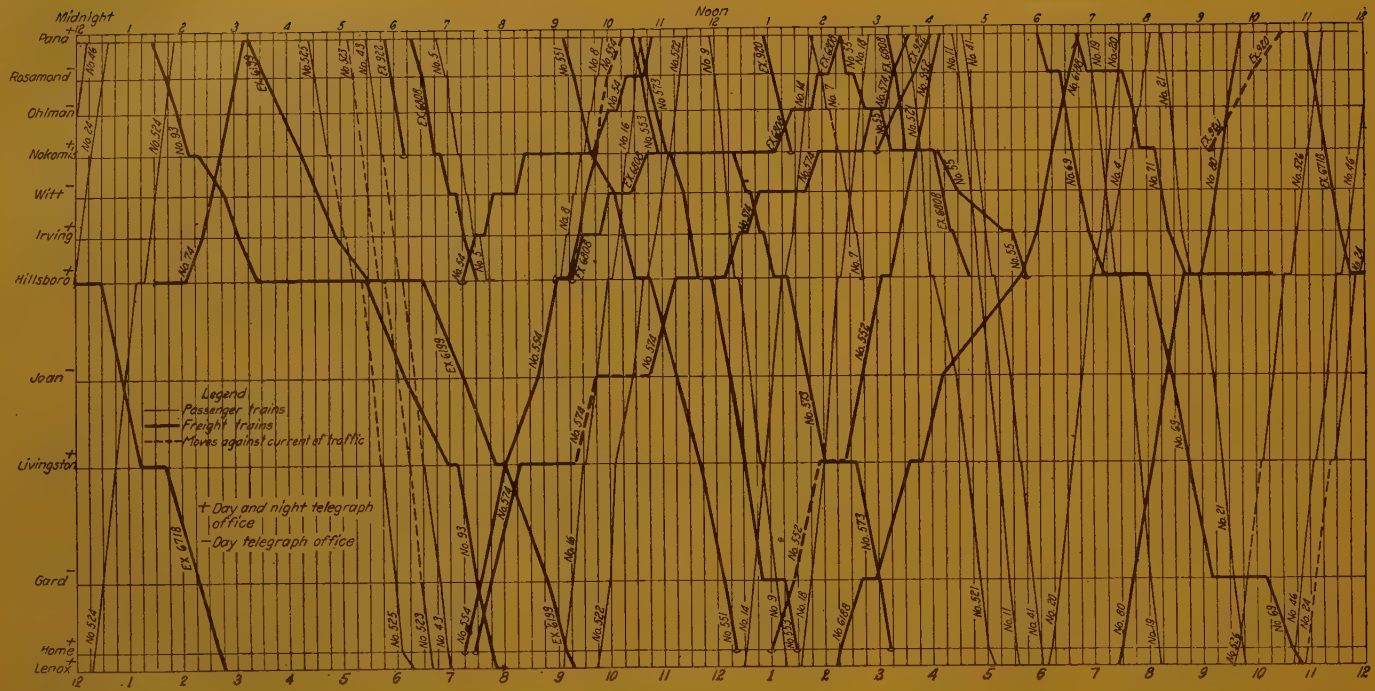


Fig. 3. — Train movement chart on district of St. Louis division showing movement against current.

18 eastbound and 18 westbound passenger trains and 20 freight trains eastbound and 14 westbound. In this district, 12 eastbound and 1 westbound passenger trains were operated against the current of traffic while 4 eastbound and 2 westbound freights were operated in this manner. These movements resulted in the saving of 183 minutes. On the St. Louis division, between Pana, Ill., and Lenox, a distance of 70.6 miles, there were 11 eastbound and 11 westbound passenger trains and 11 eastbound and 13 westbound freight trains. Of this number, 4 westbound and 2 eastbound passenger trains were operated against the current of traffic. Four eastbound freights were likewise operated in this manner. A saving of 339 minutes was made in this territory and one train was prevented from tying up under the 16 hour law.

Results in dollars and cents.

Between Cleveland, Ohio, and Bellefontaine, a distance of 140.7 miles, 19 passenger trains westbound and 20 passengers eastbound were operated in addition to 24 westbound freights and 22 eastbound freights. Out of this number, 12 eastbound and 11 westbound passenger trains were operated against the current of traffic as were 6 eastbound freights and 5 westbound freights. This resulted in a saving of 1 358 minutes and prevented five trains from tying up under the 16 hour law. Of the 1 358 minutes 570 minutes were saved in the district between Cleveland and Galion, a distance of 79.8 miles.

Capitalizing the saving of 1 880 minutes in time at 40 cents a minute, the resultant saving would be 1 880 × 0.40 or $752 a day. For the year it would amount to $274 480 for the districts on which the study was made. The figure of 40 cents a minute is based on repairs, depreciation, fuel, water, lubricants, other supplies, engine house expense, wages of enginemen, interest on engines, overhead expense, interest on facilities, maintenance of facilities, depreciation of facilities, wages of trainmen, train supplies and expenses, caboose expenses and overhead expense.

In arriving at the dollars and cents value of the locomotives released for service sooner, the following results are shown, basing the calculations on the formula developed by the Committee on Economics of the Signal section, American Railway Association.

Locomotive saved per day due to saving train hours.

1° 1 880 minutes = 31.33 hours saved in moving equipment.

2° 31.33 × 365 = 11 435.5 hours a year.

3° Locomotives saved $= \frac{31.33}{24 \text{ hours}} = 1.3.$

4° Locomotives at, average, $66 000 × 1.3 . . . . . = $85 800

Savings per year on locomotives saved :

Interest on first cost at.	6 %
Maintenance, repairs and depreciation charge. . .	20 %
	26 %

5° Locomotives at 26 °/₀ of $85 800 amount saved a year. . . . . = $21 308

Coal saved a year due to saving train hours (based on 1 ton saved per train hour).

6° $3.68 × 31.33 hours = $115.29 a day.

7° $115.29 × 365 days. . . . . = $42 080

$63 388

Cars saved per day due to saving train hours.

104 freight trains involved.

8° Freight cars per train, average number, 50.

9° Cars saved = $\frac{\text{train hours saved} \times \text{cars}}{\text{24 hours}} = \frac{31\ 33 \times 50}{24} = \frac{1\ 566.5}{24}$ (car hours) = 65.3.

10° Cars at, average, $2 800 × 65.3. . . . . = $182 840

Savings per year on cars used :

Interest on first cost at.	6 °/₀
Maintenance, repairs and depreciation	10 °/₀
	16 °/₀

11° Cars at 16 °/₀ of $182 840, amount saved a year $29 254

Summary of savings.

On cost of locomotives saved	$21 308
On cost of coal, account train hours saved	42 080
On cost of cars saved	29 254
Total. . .	$92 642

No data were obtainable as to the number of stops eliminated, consequently no savings are shown to cover cost of coal saved or the savings on wear and tear of equipment. The amount of overtime saved was not developed and as a consequence no saving in overtime pay is included.

How this method of operation results in other savings.

In addition to providing for more flexible train operation and the elimination of delays by making use of either idle track, savings may be made by other departments. For example, the maintenance of way department on the St. Louis division, in laying new steel was given the exclusive use of the one track during the day, cutting the labor cost of this work in half.

ST. LOUIS DIVISION.

Table to illustrate time saved by trains operated against current of traffic.

(See « Train movement diagram », figure 3.)

TRAIN.	BETWEEN.	CAUSE.	Time saved, minutes.
		East bound.	
No. 554	Nokomis to Pana	From 9:46 a. m. to 10:15 a. m. account No. 54 ahead. If No. 554 had followed No. 54 it would have been delayed 10 minutes between Nokomis and Ohlman	10
Ex. 920	Nokomis to Pana	From 9:10 p. m. to 10:30 p. m. to prevent delay to No. 80.	55
No. 24	Home to Livingston	From 10:55 p. m. to 11:22 p. m. as No. 46 was in the block. No. 24 would have been delayed at Home 10 minutes for No. 46 to clear the block at Livingston .	10
No. 552	Gard to Livingston.	1:25 p. m. to 1:53 p. m. in order to prevent delay to itself of 35 minutes waiting at Gard for No. 18 to clear the block at Livingston	35
No. 574	Livingston to Joan	9:20 a. m. to 9:45 a. m. in order to prevent delay waiting at Livingston for passenger trains No. 16 and No. 522 to clear the block at Joan	66
		West bound.	
No. 525	Nokomis to Livingston	From 4:48 a. m. to 5:42 a. m. to prevent delay to Ex. 6199 and to No. 93 . . .	...
No. 43	Nokomis to Livingston . . .	5:47 a. m. to 6:28 a. m. to prevent delay to Ex. 6199 and to No. 93 by running No. 523 from Pana to Gard, No. 525 and No. 43 from Nokomis to Livingston against the current of traffic. This saved a delay of 102 minutes to Ex. 6199 at Nokomis to allow these three passengers to clear the block at Irving. A delay of 61 minutes was saved No. 93 at Hillsboro by running the three passenger trains against the current of traffic to clear the block at Livingston	102

Conclusions.

That this method of train operation is safe is evidenced by the fact that but one serious accident may be charged to it during the twenty-three years or more the Big Four has been operating trains against the current of traffic as a regular

practice. Essentially the operation is the same as if two single track railways were being operated between the places trains are operated against the current of traffic. Therefore, this method of operating trains is as safe as is single track operation as the Standard Code rules for single track movements are in force. No changes in rules are required. The results in time saved and delays eliminated on the three districts on which the study was made have proved the advantage in expediting traffic resulting from this method of operation. When reduced to a dollars and cents basis substantial savings yearly result. It should be borne in mind that this analysis is based on but three districts and does not cover all districts on the Big Four where this mode of operation is used.

Proportionate savings also are made on the other districts which, if added to the result obtained here show that this method of operation is well worth while.

[656 .254 (.42)]

Main line control, North Eastern Area, London & North Eastern Railway.

Figs. 1 to 4, pp. 1021 to 1026.

(From *The Railway Gazette.*)

For a long period there has been an exceedingly dense trafic over the North Eastern main line between York and Newcastle. Not only does this main line carry the whole of the East Coast traffic, but it also carries an extremely heavy traffic from the Middlesbrough and West Hartlepool areas and a large proportion of the output of the Durham coalfields between certain points on its way for shipment. Unlike other companies' lines, duplicate facilities are not abundant, and a glance at the diagrams in figure 1 will show that, as compared with other lines, there is, indeed, a relative shortage of duplicate facilities. It has, indeed, been claimed that the main line between York and Newcastle carries a more dense traffic with fewer facilities than any other main line in the country. In 1920 further considerable strain was put on the capacity of this main line in the additional operation involved by the working of emergency coal traffic from Northumberland and Durham southwards. This necessitated 60 additional trains per week, which had to be handled at a time when considerable difficulty was being experienced in operating the very heavy « boom » traffic then passing. It was therefore decided as a measure of relief to institute a control at the York headquarters for the whole of the main line between Doncaster (Shaftholme Junction) and Newcastle Central.

A diagram board with moving « Trains ».

Traffic control offices already exist on the North Eastern Railway at Newport (Middlesbrough), Gascoigne Wood and Newcastle. These offices are « traffic » control solely. In other words, they co-ordinate the traffic to be moved with the means of moving it, but they

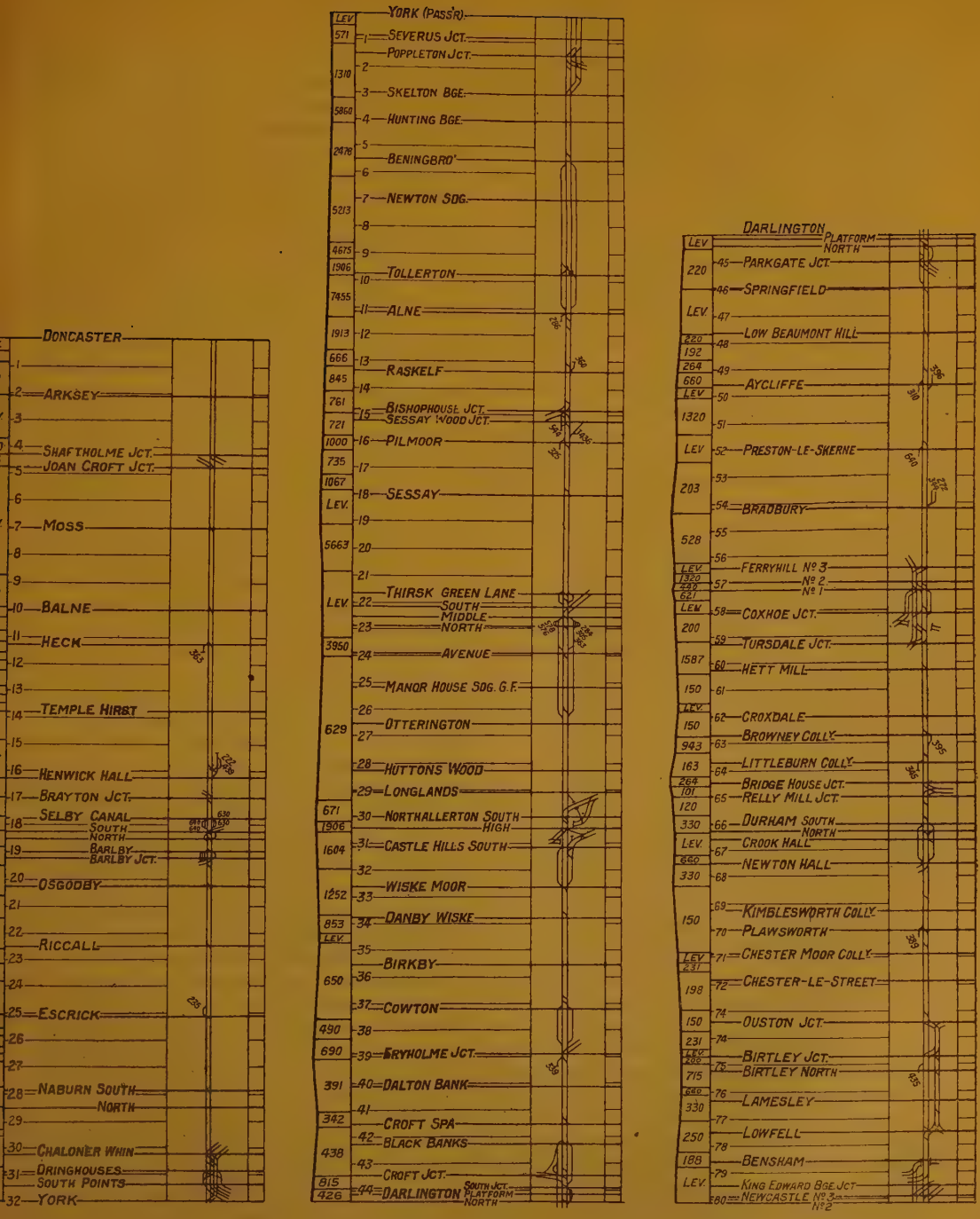


Fig. 1. — Reproduction of Doncaster-Newcastle line diagrams, showing track facilities, gradients, etc.

do not watch in detail the actual running of the trains, which may more properly be described as « train » control. The new control office at York is, however, both a train and a traffic control, and it not only deals with freight traffic and services, but it also controls the passenger train service, from the point of view of traffic requirements.

The control board at York, illustrated in figure 2, shows diagrammatically the position of every yard, station, signal-box, refuge siding, relief siding and duplicate (independent) line. In order that a more accurate picture may be presented at the larger stations, the facilities are drawn to a larger scale, and this may readily be seen in the enlarged section of York, shown in figure 3. The principle involved is that above a diagrammatic representation of the controlled line, drawn to a « running time » scale, five endless belts, driven by electric clock mechanism, through variable pulleys, operate in a « down » direction; and, similarly, five belts operate below the board in the « up » direction. The board is divided into eight sections, *viz.:*

Shaftholme Junction (Doncaster)-Selby;
Selby-York;
York-Thirsk;
Thirsk-Northallerton;
Northallerton-Darlington;
Darlington-Ferryhill;
Ferryhill-Durham;
Durham-Newcastle.

The control machinery

The machinery installed at the York control enables those responsible to see at a glance the approximate position of every train within the area. The trains are represented by cards carried in carriers which « ride » on moving belts. The type of carrier utilised consists of a small brass jockey which rides on the belt and which, when lifted off, can be easily hung on a « T ». The carriers are provided with different coloured enamelled faces, each face being descriptive of a type of train. Each carrier conveys a card on which brief particulars of the train are inserted, *i. e.*, working time-table number, description, and points of origin and termination. Additional devices can be added as required; for example, change-over turns between York and Newcastle carry « arrows » of the same colour. The controller, by watching these converging trains, which are thus provided for, can at once determine the most suitable place at which the crews can change-over, if either train is out of course.

Brass T's are screwed at every point where a train may stand or be held up by signals, the general idea being that as long as a train is running on the main line, it runs on the most suitable belt, but as soon as it is stopped, or turned from the main line, it is necessary to transfer the train represented by a carrier from the belt to the « T », the transfer back to the moving belt being effected as soon as the train is started or turned back to the main line.

In order periodically to check the running of trains automatic stops are provided at each sectional point, *i. e.*, Selby, York, Thirsk, Northallerton, Darlington, Ferryhill and Durham; these stops not only prevent the carrier going forward but also carry a pulley in the head, which normally supports the belt. The « automatic stop » shown in figure 3, can be turned down manually, when required, in the direction of the moving carrier, and consequently the carrier can be « let by » when desired. All trains are, however, reported at the seven points indicated, and it is, therefore, possible to check the running of every train at each reporting point. If the train is running at a relatively slower rate than the carrier, it is apparent that the latter will arrive at the automatic

stop on the diagram board before the former reaches the corresponding reporting point. The controller then challenges the signal-box at this point and retains the carrier at the « stop » until the train is actually reported. Similarly, if the train runs relatively faster than the carrier, it will be reported by the signalman, before the carrier actually reaches the « stop », and the necessary adjustment can be effected by moving the carrier past the stop.

For each section each belt is provided with a scale fastened behind it. This is clearly seen in the enlarged section, the scales being black, divided by white lines. The actual divisions represent minutes, and the scale represents the total running time for each of the five speeds through that section. It is possible, therefore, to see approximately how long any train has been in any section between the sectional points. The sectional lengths for each speed also carry a small number indicating the point to point timing for each particular belt, and printed and fastened above the control board at each sectional point is a table giving the actual point to point timings for all passenger trains, and classified freight trains from that point to the next sectional point on either side. The following is a copy of one of these tables. In placing a train on the belt the controller has only to find from the table the actual time-table point to point timing, and then to place the carrier on the belt whose index gives the nearest approximation to this figure. In actual practice it is found that the five belts give a very close approximation to the actual booked timings.

Adjustments of belt speeds.

The speed of each belt, adjusted through its variable pulley in conjunction with the distance fixed for the length of a section, arranged on a mathematical basis, approximates to the actual running time required for that belt in that particular section. It will be noted in the general view of the control board shown in figure 2, that the distance between Ferryhill and Durham on the down side (at the top of the board) is less than the distance between the same points on the up side (at the bottom of the board). This is accounted for by the fact that the ruling gradient is falling towards Durham, and therefore the point to point timing is proportionately less in the one case than in the other. The basis of adjustment is a speed of 147 minutes on the « down » side, this being the average express running time for the 111 miles between Shaftholme Junction, Doncaster and Newcastle Central. The other four belts on the « down » side are proportionately adjusted for speeds to represent the running time of intermediate expresses, slow passenger and class « A » freight, class « B » freight and class « C » freight. Similarly, the basis of adjustment on the up side is a speed of 146 minutes, with corresponding speeds for the other four belts.

Each set of belts (*i. e.*, up and down) are driven independently by two standard electric clocks, the driving shaft ordinarily employed for the hands being fitted with a worm driving a vertical shaft. This carries the five variable pulleys, which are adjusted to give the belt speeds. The two electric clocks are in turn driven from a master clock, which also controls the electric clocks shown in figure 2, provided for the use of the control staff. The belts are endless, the return being arranged for behind the board. They are made of a material woven from copper thread, and although sufficiently pliable do not stretch or sag. Arrangements for taking up any difference in length are, however, provided for by means of weight adjusters. A view of the up clock is given in figure 4.

From this explanation it will be apparent that any alteration in train speeds can at once be provided for by the readjustment of the requisite pulley, provided always that this alteration is applicable to that type of train throughout the controlled area. Any local alteration could only be provided for by increasing (for deceleration) or decreasing (for acceleration) the distance between the two local points on the board itself.

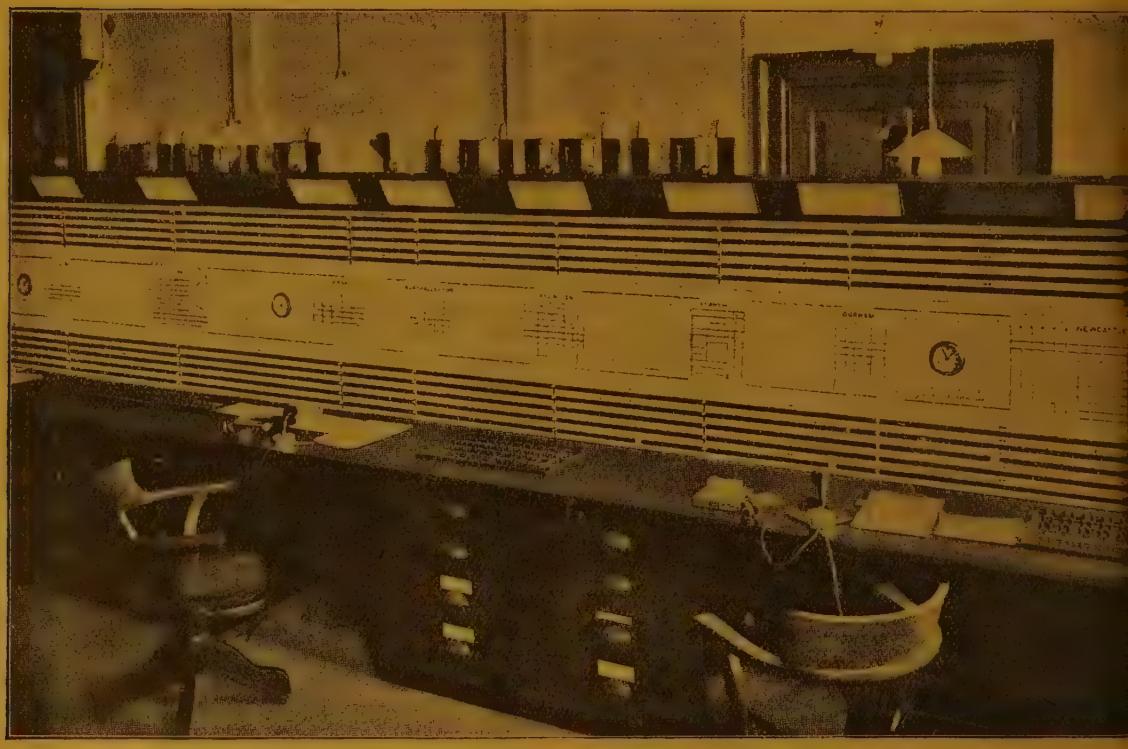


Fig. 2. — Main line control board, North Eastern Area, London & North Eastern Railway, brought into use on 9 November 1922.

The electric clock mechanism for operating the travelling belt, also the master clock and the controllled clocks working therewith, were supplied by Gent & Company Ltd., of Faraday Works, Leicester, and 25, Victoria Street, London, S.W.1. A special feature, in addition to the incorporation of what is described as a « waiting train » movement by that firm, whereby irregularities inevitable where a heavy load is imposed upon the mechanism are periodically compensated for, is the arrangement for additionally energising the operating pendulum to meet either sudden or continued accessions to the load, as may occur when the carriers are being manipulated on the belts, or a carrier comes

up against a stop, as above described. Briefly, this special device may be thus described: Normally the pendulum, under the influence of its operating electro-magnet, completes its arc of vibration, but should this tend to decrease, owing to an accession of load, a suspended « trailing nib », instead of passing freely over a notched block, engages therewith, and by a toggle action depresses it to complete a supplementary circuit to cause the main operating magnet to give an additional energising impulse to the pendulum.

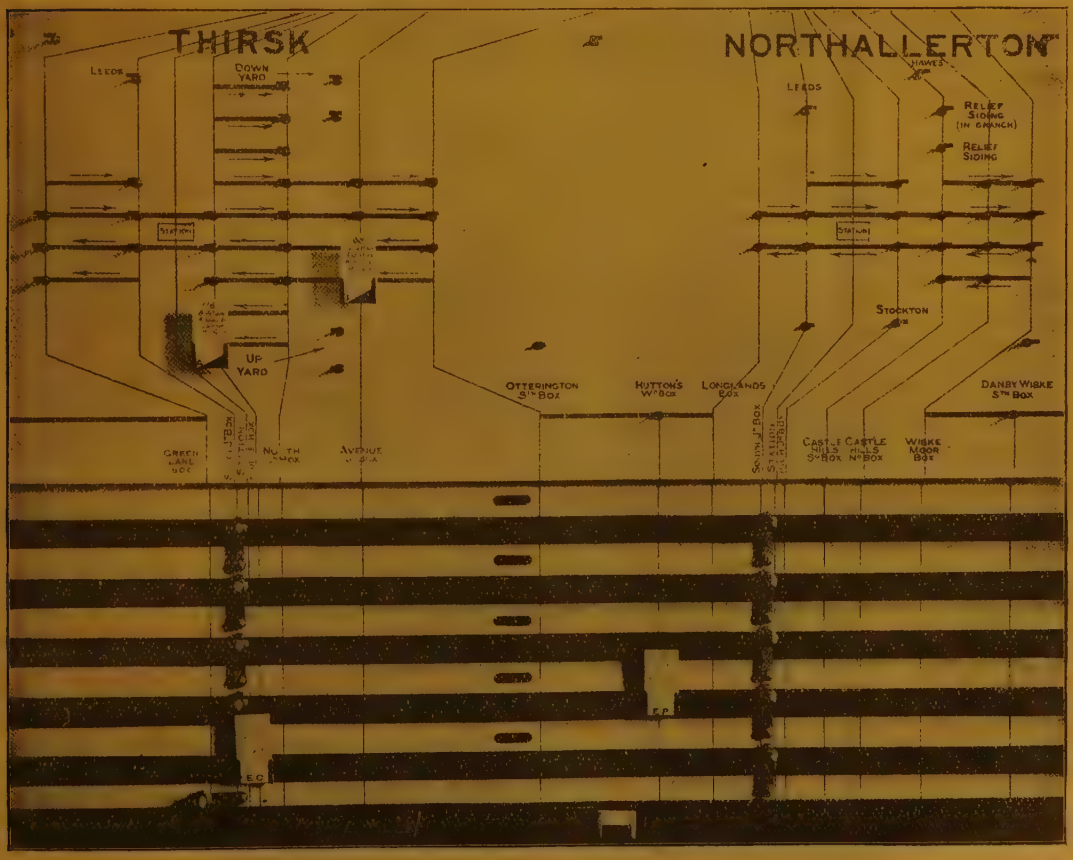


Fig. 3. — Enlarged section of control board, showing « up » line between Northallerton (on right) and Thirsk (on left) at 2.23 p. m.

The 12.5 p. m. (intermediate) E. P. West Hartlepool-Leeds has left Northallerton at 2.20 p. m. The 10.15 a. m. East Coast express, Edinburg-King's Cross has just been reported passing Thirsk, and the « stop » is down. The 12.20 p. m. class « B » goods, West Hartlepool-Ripon is running on the Up Independent between Otterington and Thirsk. The 8.40 a. m. class « A » goods, Heaton-Milford Junction is standing in Thirsk Up Yard waiting its main line path, at 2.30 p. m.

The control office organisation.

One deputy chief controller, two controllers and three assistant controllers comprise the control staff on each of the three daily shifts. The deputy chief controllers are responsible to the heads of the general superintendent's passen-

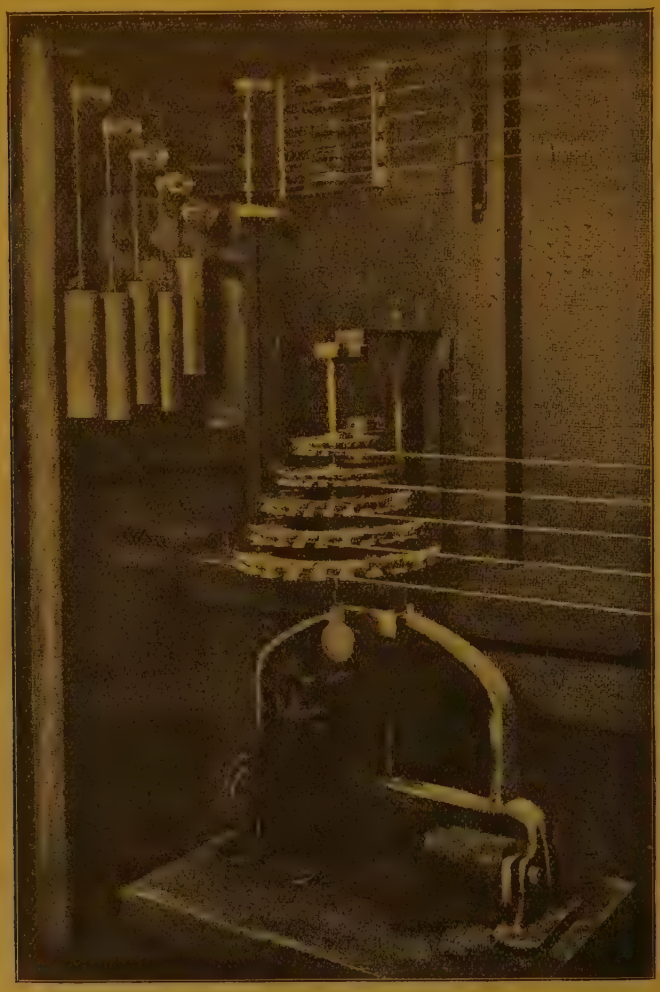


Fig. 4. — « Up » clock, showing electrical drive and variable pulleys.

ger and freight sections who act as joint chief controllers. Each deputy chief controller is responsible for the whole of the work of the office in his shift, and in addition to the « train » control, described above, he is responsible for the « traffic » control, not only in the actual area controlled, but also for all traffic which has to move into the area from outside points. In this respect the work

THIRSK

Up

No. of Train	Arr.	Dep.	To	To York
	a. m.	a. m.		Mins
300	12	24	King's X ...	24
302	12	46	" ...	24
7	2	21 Q	" ..	25
10	2	37	" ...	24
11	2	52 MX	" ..	25
18	H & C 3	10 MX	" ...	25
45	7 18	7 22	York.....	52
73	—	7 15	"	—
		(Pickering)		
77	8 59	9 4	"	26
88	9	14	Bournemth..	28
91	9	30	King's X ...	25
99	9 59	10 3 so	York.....	50
127	11	8	Swansea....	26
130	—	9 58	York.....	—
		(Pickering)		
135	Relief 11	32 Q	King's X ...	25
136	11	46	" ...	24
	p. m.	p. m.		
139	Pels 12 42	12 52	York.....	31
143	1 3	1 6	"	53
162	1	50	"	24
166	2	10	King's X ...	24
170	2	25	Southampton	24
195	4 16	4 21	York.....	27

No. of Train	Arr.	Dep.	To	To York
	p. m.	p. m.		Mins.
190	H&C 4 38	4 48	York	32
203	5 8	5 11	"	53
209	5	34	"	23
210	5	48	King's X..	24
218	Pels 6 55	7 5	York	40
221	6	24	Liverpool..	24
225	—	5 47	York	—
		(Pickering)		
233	Bkd. Fish and Meat 6	40 sx	King's X..	25
238	7 38	7 42	York	48
255	Bkd. Fish 8	15	King's X..	28
	Frequently runs in two portions. — See note W. T. T.			
258	8	51	Sheffield...	25
263	9 1	9 7	York	27
271	9	22	Leeds.....	20
273	Relief Bkd. Fish 9	33 sx Q	King's X..	25
276	Bkd. Fish 9	45 sx	" ..	25
276	Bkd. Fish 9	45 so Q	" ..	25
283	Braked Fish 10	23 sx Q	" ..	24
291	Pels 11 40	11 48 sx	York	32

FREIGHT (Thirsk pass to Severus Junction arr.)

	Mins.		Mins.
Class A....	45	Class C....	65
" B....	53		

Down

1-11-22

No. of Train	Arr.	Dep.	To	To Northallerton
	a. m.	a. m.		Mins.
310	12	8 MX	Glasgow	8
12	Parcels 12	58 MX	Edinburgh ..	10
16	1	36	" ..	9
19	Pels 1 43	1 51 MX	Newcastle...	12
32	3	7	Edinburgh ..	8
33	3	21	" ..	9
35	3	49	Newcastle...	9
43	4	16 MX	" ...	10
43	4 16	4 18 MO	" ...	10
45	4 25	4 28 MX	" ..	12
49	Parcels 4	42 MX	" ...	11
85	7 16	7 27	West H'pool.	16
90	7 55	8 0	Newcastle...	15
110	9 11	9 13	West H'pool.	12
113	9 20	9 22	Darlington..	15
117	10	2	Glasgow	8
121	Pels 10 15	11 30	West H'pool.	15
126	10	31	Edinburgh ..	10
131	10 50	10 52	West H'pool.	11
144	Pels 11 1	11 11	Newcastle...	13
	p. m.	p. m.		
158	Directors' Special 12	4 Q	" ..	12
161	12 28	12 32	N'thallerton.	12
165	12 47	12 49	Newcastle...	16
167	Ely Stock 1 5	1 20 Q	" ...	12

No. of Train	Arr.	Dep.	To	To North allerton
	p. m.	p. m.		Mins.
169	1	16	Newcastle...	10
176	1	58	" ...	7
180	2	16 Q	Edinburgh ..	8
182	2	28	" ..	8
186	2 51	2 56	West H'pool.	15
190	Rlf. 3 2	3 6 so	Darlington..	12
193	3 12	3 15	Newcastle...	12
211	4	7	Glasgow	8
230	5 0	5 3	N'thallerton.	12
236	5	14	Newcastle...	9
242	5	38	Edinburgh ..	8
245	6 7	6 10	Darlington..	15
253	6	2	Newcastle...	10
259	7 28	7 33	West H'pool.	14
265	7 42	7 46	Darlington..	16
272	8 27	8 29	Newcastle...	11
293	9 27	9 30	West H'pool.	11
295	9	41	Newcastle...	7
298	9	55 Con	" ...	11
301	Braked Goods 10	21 sx	Glasgow	12
309	11	56 sx	Aberdeen...	8

FREIGHT (Thirsk pass to Northallerton pass.)

	Mins.		Mins.
Class A...	15	Class C...	24
" B...	19		

Specimen list on York train control board showing point to point times to enable controller to select correct cord for carrier.

of this control office approximates very largely to the co-ordinating work performed in a headquarters' control office, on a system where control is instituted on a wide basis. Additionally, in so far as the area controlled is concerned it functions as a local control office, except that detail operation inside a yard or station is left to the local authority, although periodic stocks are given off to the control office.

The board is manipulated by three assistant controllers, each taking one section, the sections being :

Newcastle-Darlington North Junction (inclusive) ;

Darlington South Junction (inclusive)-York (exclusive) ;

York (inclusive)-Shaftholme Junction, Doncaster.

Each assistant controller is linked by telephone to all the signal-boxes in his section with a few exceptions, minor boxes of no strategic importance being omitted. Signalmen are held responsible for reporting all cases when delay is caused to a train by signals, when a train is turned from or to the main line, and where unusual occurrences take place. The signalmen at the seven sectional points have also to report the passage of all trains. From this information, each assistant controller is able to keep his section of the board properly carded. By this means one is able to ascertain at a glance the situation on this important section of the North Eastern main line, practically minute by minute.

Operating records maintained.

Records of the operations are kept in two forms. Trains which are local to the section of an assistant controller are tabulated on four sheets for daily use, *i. e.*, up and down passenger and up and down freight. Trains which pass through the sections of two or three assistant controllers are recorded on cards of distinctive colours, the cards being transferred as the train passes from one section into another. These cards are subsequently tabulated and the cards themselves are available for the general superintendent's staff to judge the particular performance, considerable care being taken that all delays and their reasons, also losses of time debitable to engine, are properly entered up. The cards also contain full information as to the « traffic » results, this information being entered up prior to the train being run, and therefore before the card is passed to the assistant controller.

The loading of both passenger and freight trains is closely watched. On the passenger side, a close watch is kept of the loading of all the more important passenger trains, with a view to the load approximating to the capacity of the engine for the particular speed at which that train has to run. The passenger traffic record is kept on the back of the card, utilised for the passenger train control, the two sides of this card thus giving full information as to the loading and performance of the particular train. By this means it is possible to arrange maximum permissible loads without overloading, and to provide adequate and convenient services for extra vehicles. On the freight side, the loading is closely supervised, and arrangements for making up trains can be made simply and easily by watching the loads, and the periodic stocks given off every six or eight hours by the yard in the controlled area. Adequate arrangements and instructions have also been issued, and are in force to provide for the best use of any additional locomotive power, while relief advices can be passed forward rapidly and efficiently.

In connection with freight traffic, the general arrangements do not differ materially from those in force at other traffic controls established both on the North Eastern and on other lines in this

country. The unique features of the York control office are undoubtedly the mechanical means to determine the position of every train, passenger or freight, the length of line controlled, and the special arrangements for passenger control, train and traffic.

Telephonic arrangements.

The telephone arrangements are of the Western Electric Selector system. There are six main circuits, three double sets covering the sections, Newcastle-Darlington, Darlington-York (exclusive), York (inclusive), Shaftholme Junction, Doncaster. Three circuits are linked up to the signal-boxes only, and upon them the assistant controller and signalmen operate. Signalmen obtain « Control » by pressing a cut-off key and listening in. If no conversation is taking place, they call attention and state their communication, the assistant controller at the other end being provided with a head-piece receiver. To reply, the assistant controller need only depress the battery switch with his foot and speak direct. To call up he must, however, utilise the particular Selector ringing up for the box required. There are no less than 26 instruments on each of these signal-box circuits, but no difficulty is experienced in using them, and so far, they have been free from faults. Each of these three circuits is also provided with a general call, which is utilised only in exceptional circumstances. Signalmen who cannot reply to the general call immediately, are instructed to call up control and inquire what the message is as soon as they are able. Duplicate plugholes are provided on each of these circuits so that the deputy chief controller may listen in with a hand set, when necessary. In the event of to the assistant controller having to disconnect his instrument, the call of any signalman is automatically heard through a special loud-speaking horn fixed over the control board. This arrangement is particularly useful for Sunday work when the control office is operated with a reduced staff. There are three Selector circuits also covering the same sections as the signal-box circuits, linked up to all the district superintendent's offices, except Hull and Leeds, the principal yards in the controlled area, the control offices at Newport and Newcastle, the principal stations, the yardmaster at Doncaster, and the control office at Hexthorpe. There are 13 instruments on each of these circuits, outwards calls being made by Selector ringing, inwards calls by special ringing key giving a light over the Selector board concerned. No special arrangements for cutting off current are necessary as ordinary telephones are provided.

The current for the operation of the telephones, clocks and lights is supplied by a battery consisting of about 800 dry cells, and about 126 secondary cells, which are accommodated in a separate battery room, specially built, outside the main headquarters office. It is interesting to note that the voltage employed on the six Selector circuits varies from 135 to 185 volts.

[656 .253 (.42)]

New day colour-light signalling on the London & North Eastern Railway.

Figs. 1 to 6, pp. 1032 to 1034.

(From the *Modern transport.*)

A new system of signalling, of particular interest, in view of the fact that it constitutes the first application on any railway in Great Britain of the three-aspect day colour light principle, has recently been completed on the Great Central Section of the London & North Eastern Railway between Marylebone and Wembley Hill. The decision to undertake this work, was prompted by a desire on the part of the company to run a three-minute service of trains to and from a new station, which they have erected on a new loop line in the grounds of the British Empire Exhibition. The installation, which was carried out by the Westinghouse Brake & Saxby Signal Co., Limited, of 82, York Road, King's Cross, N., was actually brought into use on 8 April 1923, three weeks before the day of the football Cup Final at the Stadium, when under traffic conditions it was found entirely satisfactory. We are now enabled, through the courtesy of the London and North Eastern Railway Company, to give full details and illustrations of this important new work.

General arrangement.

The up and down fast lines have been track circuited throughout the distance covered by the new installation. The track circuiting extends from a point 670 yards from the buffer stops at Marylebone Station, as far as Wembley Hill Station (home signal on the up line), and to a point approximately 100 yards in front of the Neasden advance starting signal. There is also track circuiting on the Exhibition loop line, on the down loop between Neasden North and Wembley Hill signal boxes and on the up loop between the up inner home Neasden North and Neasden South signal boxes. On the up and down fast (or main) lines between Marylebone Goods Yard and Neasden South signal boxes, a distance of about 4 3/4 miles, automatic or semi-automatic colour light three-position signals have been installed. « Danger », « caution », and « all clear » indications are shown in these signals by means of red, yellow and green lights respectively. Details of the type and working of the signals will be given later. The three-position signals are automatically replaced to danger by track circuit, the joints being located for this purpose from 75 to 115 feet in advance of the respective signals. The automatic signals remain at danger until the train has passed the clearing point, or overlap, ahead of the signal in advance, when the yellow, or « caution », light is shown. The green, or « all right » signal is automatically given when the train has passed the clearing point beyond the second signal in advance. The distance of these clearing points in advance of the signals varies from 180 to 635 yards, according to the relative gradient and the permissible or possible speed of the trains.

Position of signals and clearance points

As already mentioned, the signalling scheme is based upon a time interval to

permit of a three-minute service of passenger trains, the automatic signals being placed at varying distances apart according to gradient and train speed. On the down road the distance varies from 1 068 to 1 420, and averages 1 216 yards, whilst on the up road it varies from 1 125 to 1 440, and averages 1 500 yards. At the outset the problem confronting the company's signal superintendent, Mr. A. F. Bound, under whose supervision the whole of the work was subsequently carried out, involved the fixing of the position of each of the new signals, and it was only after careful study and a long series of experiments that the solution was ultimately arrived at.

Experimental working.

A three-minute service was required. The known factors were that the distance between Marylebone Station and Wembley Hill Station was just under 6 1/2 miles, and the scheduled running time from start to stop was fixed at twelve minutes. As a first requisite it was necessary to divide up the section interval of time, and it was decided to take one minute as the unit. On 2 and 3 August 1922 two trips in each direction were taken, and from the rear brake van paper bags containing a red powder for the first trip and a blue powder for the second trip were thrown out on to the line at intervals of one minute from the starting up of the train. Upon examination of the two sets of markings it was observed that, whilst a few of the blue coincided with the red, other blue markings either lagged or were in advance of the red markers, due to the different points of acceleration, difference in taking gradients, and observance of speed limits. As a train travelling in the scheduled time, but with the greatest lag at the minute intervals, would govern the position of signals and clearance points, it was decided to erect marker boards for each road at a mark nearest to the starting point, regardless of whether it was a red or a blue indication, and then to take a series of extended trips, noting any adjustments required in the position of the marker board. A sketch was prepared showing the position of the marker boards as originally fixed.

Trial trips.

During the week commencing 14 August a series of trial trips was made, and it was found that in every case adjustments in the position of the marker boards were necessary. The amended positions of the marker boards and the distance they were moved were then recorded. A further test was taken on 23 and 25 August, and it was found that on the down line only three marker boards, numbered 6, 7, 8, required refixing, whilst on the up line only two marker boards (Nos. 1 and 2) were affected. A third sketch was then prepared, shewing the further amended and final positions of the marker boards A further test was made on 31 August, and it was found that no train running in the scheduled time lagged behind the marker boards. The following day an ordinary train, strengthened to equal the proposed Special Exhibition trains, was run, and the timings of this and also of an up and a down express were obtained.

From the foregoing particulars it was possible to proceed with the making up of a graph showing : 1° Position of marker boards as first fixed; 2° position of marker boards as finally fixed; 3° average running time (up eleven trains, down fifteen trains); 4° running time of up express and down express; and 5° running time of special train. These details having been entered on the graph it was then possible to proceed with the plotting out of a suggested timing for the special trains, and the required information for the spacing of the signals was thus obtained.

Fig. 1. — Westinghouse day three-colour light signal, mounted on top of relay and transformer case.

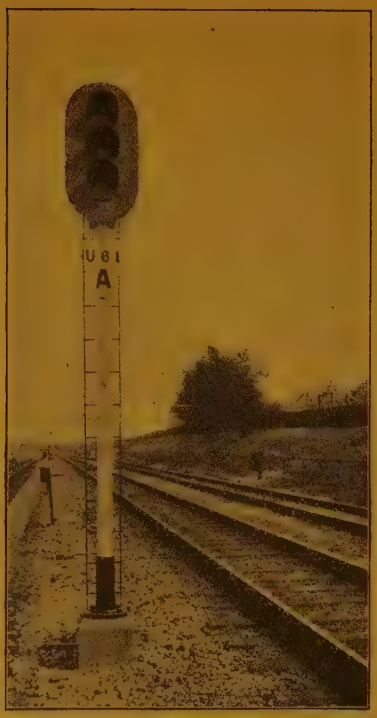


Fig. 2. — Westinghouse day three-colour light signal on independant post. Relay and transformer box can be opposite side of track.

Fig. 3. — Starting signal, exhibition loop; « Hall » three-indication signal.

Fig. 4. — Side view of « Hall » signal shewing suspension.

Westinghouse day colour-light signals.

Day colour-light signals have been in use for some considerable time on certain foreign railways, but recent improvements in electric lamps and lenses have enabled this type of signal to be very considerably improved, and there is little doubt that the results now obtained justify its use under the most exacting conditions. The main advantages of the day colour-light signal over other types may be summarised as : 1° the same indication by day or night; 2° long range; 3° visibility in fog; and 4° simplicity. Two types of day colour-light signal have been installed between Marylebone and Wembley Hill, namely, that of the Westinghouse Brake and Saxby Signal Company and the « Hall » signal of the General Electric Company. The Westinghouse signal, views of which are given in figures 1 and 2, has an apparatus consisting of a cast-iron casing divided into three compartments, each of which contains the lens' combination and lamps. Each compartment is a distinct unit, and carries at the front a lens combination, which comprises an inner colour lens and an outer clear glass lens. The inner lens is 5 1/2 inches in diameter, and collects a larger proportion of the light from the lamp placed at its focus which it projects on the outer lens; the latter reduces the rays passed by the inner lens to nearly parallel beam. Small hoods are placed above the outer lenses, and project forward in such a way that they shield them from other external light without interfering with the signal aspects, a display board being provided to form a background for the colour aspects. An additional compartment is provided at the bottom of the case in which is mounted a terminal board. The transformers are not fixed in the signal case itself, but are mounted in a case situated in a convenient position near the signal. The primary windings of the transformers are provided with taps to enable full voltage to be maintained on the lamps when the supply voltage is 5 % below its normal value. It may be mentioned that when these signals are installed on a straight section of track the lenses emit a beam of light with a dispersion of 5°. To meet the requirements of visibility on curves the signal is fitted with a deflecting prismatic lens, which has the effect of isolating certain of the rays from the signal lens and deflecting them sideways; the beam so formed also has a dispersion of 5°, and the two beams together are arranged to overlap slightly, so that there is no point on the curve of travel at which the driver is unable to obtain a proper view.

The Hall colour-light signal.

Although the Westinghouse signal has been used on the intermediate sections, an almost equal number of « Hall » signals, as supplied by the General Electric Co., Limited, of Magnet House, Kingsway, W. C. 2, have been provided principally at semi-automatic locations at Marylebone and also at Neasden. Illustrations of this type of signal in use on the newly signalled section are given in figures 3, 4 and 5. A Hall three-indication single lens' signal was installed for trial purposes near Willesden Green some months ago, and we are informed that most satisfactory results were obtained. The signal was afterwards fixed in one of the tunnels near Marylebone, where further exhaustive tests were carried out, these indicating that the signal would be highly suitable for the then proposed automatic signalling between Marylebone and Wembley. Various advantages are claimed by its advocates for the Hall signal, amongst which are low current consumption and the small space required for fixing the signal.

In this signal only one light and one lens are used, as shown in detail in the drawing, figure 5. The lamp is fixed

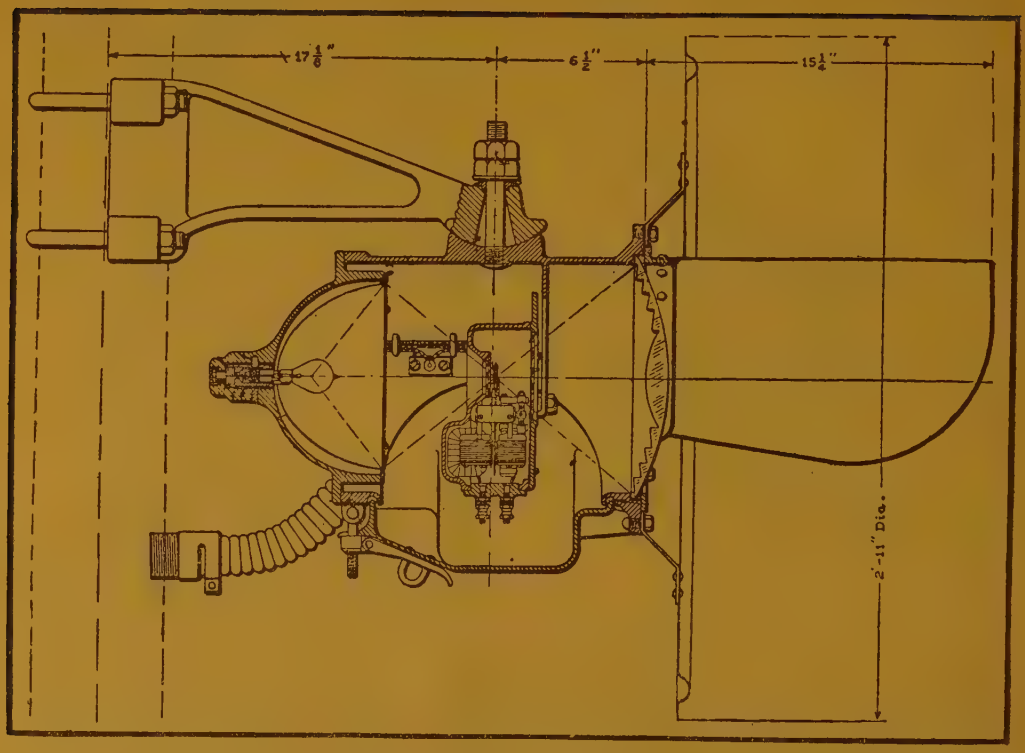


Fig. 5. — « Hall » three-indication colour-light signal ; sectional drawing.

Fig. 6. — Repeaters in Marylebone goods yard signal box, used in conjunction with the « Hall » colour-light signal.

at the focal point of an elliptical reflector, and the point where the reflected rays converge is the focal point of the lens. At this point is situated the member of the movement which carries the coloured roundels which give colour to the light rays. With the control coil of the movement de-energised, a red indication is given by gravity; with current passing through the coils in one direction a yellow indication is given; by reversing this current the green indication appears. The voltage of the lamp in all cases is only six, and the current required for operating the control movement is only 18-watts for D. C., and 1-volt ampere for A. C. signals. Thus, by having a movement in the signal which controls all indications, it does away with the necessity of control relays which must otherwise be fixed adjacent to the signal. The lamp is made with two filaments, and, should the main filament burn out, a special cut-in relay, which is fixed in the signal, automatically brings the second filament into use. A transformer for use with A. C. signals has been supplied to give the necessary voltage to the signals on the Marylebone-Wembley section. The signal is suspended by a cantilever bracket with a universal joint, and a device is fitted for quick sighting.

For the Marylebone-Wembley scheme a new type of signal repeater has been provided in the signal box. This repeater, which is illustrated in figure 6, is more or less a miniature Hall signal, and is operated on the same principle. It is fitted in a bras case 4 1/4 inch diameter, and has one lens of 1 inch diameter. The three colour indications — red, green and yellow — are repeated, and in the case of the signal not shewing a light at all a blank aspect is exhibited to the signalman.

Control of signals.

The principle of control for the automatic signals is what is generally known as the polarised track circuit system, this being its first application in this country in connection with three-aspect colour-light signals. Roughly speaking, the system of control is as follows : 1° To obtain the yellow, or « caution », indication the track for overlap distance beyond the signal, the track circuit from overlap point to the next signal, and also the overlap track beyond the latter must always be clear; 2° to obtain a green, or « all right », indication, all the track circuits referred to must be clear, and, in addition, the next signal ahead must be shewing either yellow or green. The overlap track circuits are in all cases fitted with two-position relays, but the intermediate or berth track circuits, *i. e.*, the track circuits from the overlap point up to the next signal, are fitted with a three-position relay.

Relay indicators.

With the signal ahead in the red, or danger position, but which the overlap beyond this signal clear, the track relay of the berth track will be energised in one particular direction. To assist the linesman, indicators painted yellow and green are provided, and the relay, under these conditions, will have its pointer on the yellow mark. If the next signal ahead is shewing either yellow or green then the relay of the berth track circuit will be energised in the reverse direction, and the indicator will be pointing to the green mark. It will be realised that the contacts on the berth relay can, in conjunction with the relay of the overlap track, easily be arranged to give the various colour indications. The berth relay, however, is sometimes as much as 600 feet away from the signal which it controls, and, for this reason, it has been found desirable in nearly all instances to provide a repeater, or « T. P. » relay, at the signal, this line relay being provided with similar colour indications and operating simultaneously with the

berth relay. The overlap track circuit in all cases relays the berth track circuit, the primary winding of the track transformer being taken over the overlap relay contacts.

Each signal is provided with a relay known as the « G. R. », or signal relay. This relay, when de-energised, closes the circuit to the red lamp, and, when energised closes the circuits to either the yellow or green lamps, in accordance with the position of the « T. P. » relay. This « G. R. » relay is of the slow return type, *i. e.*, after current is cut off from its windings a period longer than ordinarily is the case elapses before the front contact opens. This period is approximately 0.7 of a second, and the delay in action is provided to bridge the changing over of the three-position track relay and its repeater. A proving circuit is also provided, this ensures that at any automatic signal, after the passage of a train, the « G. R. » relay shall have dropped to the de-energised position.

Track circuits.

The whole of the track circuits in the new installation are supplied with current from track service sets, generally known as the Westinghouse condenser feed sets. These sets comprise a small transformer, the primary winding of which is connected in series with a condenser across the 100-volt supply, and the secondary of the transformer is connected directly to the running rails. Both primary and secondary of the transformer are provided with tappings, and the condenser is also fitted with terminals, so that various amounts of capacity can be included in the circuit. The whole apparatus is mounted behind a slate terminal board, and, by means of various links, adjustments can be made, both in the amount of capacity in the circuit and in the number of turns in primary and secondary. The impedence of the two portions of the circuit can therefore be varied in such a manner as to ensure practically a constant supply of current to the track circuit; very considerable variations can also be made in the phase displacement of the secondary current. This variation of phase is most important when two-element vane relays are used, as, to secure the greatest efficiency, the currents in local and track windings should be displaced in phase by 90°; the phase of the supply current at the track circuit transformer needs to be considerably different for a long damp track than it is for a comparatively short track with high ballast resistance. Track circuits are installed which vary from 1 000 yards in length to a distance of only a few rail lengths.

Supply of current.

Current for the operation and lighting of the new signalling installation is obtained at 200 volts D. C. from the main busbars of the London & North Eastern Railway Company's power station at Marylebone. For this purpose two motor alternator sets with switch board have been supplied by the Westinghouse Brake & Saxby Signal Co., Limited, and installed by the railway company. These sets have 200-volt direct current motors and 600-volt alternating current generators supplying current to the signals at 600 volts 50 cycles. The current is distributed by a main cable which runs from the power house direct to Marylebone Goods Yard signal box and thence parallel to the track as far as Wembley Hill Station, a distance of approximately 6 1/2 miles. It is of interest to note that this is probably the longest distance to which a 600-volt supply has so far been distributed for signalling purposes. The voltage at the far end of the line is 580 volts. To secure this result without the use of very heavy copper conductors booster transformers have been used, two of these being situated at intervals on the newly signalled section. The

power is tapped from the 600-volt mains at all signal cabins and at convenient points for supplying automatic signals or track circuit apparatus. Current is transformed to a pressure of 100 volts for the energisation of the relay locals, the primaries of the track transformers and other similar purposes. A tapping at 12 volts is also provided on the main transformers; this supplies current for the lamps in the light signals and, in certain cases, for the lamps in the illuminated diagrams in the signal boxes.

[385 .113 (.45)]

The Italian State Railways during the financial years 1920-1921 and 1921-1922.

During the year 1920-1921 the operation of the Italian railways suffered considerably from the difficulties arising out of the continued abnormal condition of the country, the principal characteristics of which were unrest among the railway personnel, new working conditions, and either stationary or diminishing traffic returns.

The length of line in operation, excluding the Dalmatian lines which were only operated up to the 10 June 1921, increased between the 30 June 1920 and the 30 June 1921 by 15 km. 392 (9.564 miles) for standard gauge and by 43 km. 825 (27.232 miles) for narrow gauge.

As a result of the depreciation of money values and the increased cost of working, tariffs were raised progressively, so that up to November 1920 the average increase for passengers was from 180 to 230 %, and for goods and freight from 180 to 300 %.

There were constant interruptions in the service owing to political or social disturbances. These interruptions were almost all of a local character, but as they manifested themselves unexpectedly in different centres, they adversely influenced the regularity of traffic generally. They became less frequent towards the end of the year, various economic and other advantages having been granted to the personnel by law.

The practical application of the eight-hour day (which for political reasons had been nominally adopted towards the end of the preceding year, when the railways were not in a position to meet the requirements which it entailed) had a very disturbing influence on the work of the year 1920-1921. The running of trains and the regularity of transport were particularly affected by it, largely because of the difficulty of adjusting the new working-house to the existing engine and train staffs.

The total personnel, excluding those employed on the railways of Sicily and Libya, increased from 216 075 (30 June 1920) to 229 078 (30 June 1921), or from 13.74 to 14.66 per kilometre (22.11 to 23.59 per mile). The increase was due to the fact that the railways had to re-engage those employees who had been absent on military service (to comply with legislation passed previously) and find occupation for those employees who had been incapacitated through the war. The increase was, however, largely counteracted by the effect of the shortening of the working-day.

The supervisory staff maintained its percentage of 0.69 of the total personnel, while the administrative staff decreased from 7.58 to 7.17 %, and the executive staff increased from 91.73 to 92.14 %.

The ordinary upkeep of the perma-

nent way, the construction of new installations on existing lines, and the construction of new lines, were continued in spite of the increase in the cost of materials and labour. The increase in siding accommodation however (an increase of 30.6 % as compared with the pre-war figure), remained below the increase in rolling-stock (40.4 %), and this rendered working conditions more difficult.

Electric and hydro-electric installations for the production of current were considerably extended, and the total length of electrified line increased by 67 km. (41.6 miles).

The following new lines were opened: Rome to Carano, standard gauge, on the direct route from Rome to Naples, togheter with the Carano-Carroceto branch line; and the narrow gauge lines from Grottacalda to Piazza Armerina, from Prizzi to Palazzo Adriano, from Favara to Girgenti, from Filaga to Contuberna, and from Cavalcatore to Assoro, on the light railways of Sicily.

Owing to the construction of new rolling-stock, the amount of rolling-stock per kilometre of standard gauge line increased slightly, from 0.415 to 0.419 (0.668 to 0.674 per mile) for locomotives, from 0.695 to 0.704 (1.118 to 1.133 per mile) for carriages, from 0.285 to 0.299 (0.459 to 0.481 per mile) for luggage-vans, and from 9.230 to 9.488 (14.954 to 15.269 per mile) for wagons.

Although it had been possible, thanks to the exceptional measures adopted, to accelerate considerably the repair of rolling-stock, whether carried out by private firms or by the railways themselves, the condition in which the rolling-stock was left after the war was so bad that the average percentage under repair increased from 27.6 to 30.0 for locomotives, from 34.7 to 35.1 for luggage-vans, and from 16.2 to 17.0 for wagons; though the percentage for carriages decreased from 39.6 to 38.6.

The amount of rolling-stock in running order per kilometre of line decreased from 0.316 to 0.301 (0.509 to 0.484 per mile) for locomotives, and increased from 8.593 to 9.095 (13.829 to 14.637 per mile) for other vehicles.

The output of new locomotives by private firms increased, although the work was hindered by strikes and financial difficulties

The necessity of using a large proportion of German coal, often of inferior quality, continued to be the cause of considerable irregularity in the running of trains.

The financial results in respect of the whole standard and narrow gauge system comprised within the old frontiers (including the navigation of the Straits of Messina) were : receipts, 3 021 million 272 425.85 lire; expenditure, 4 066 million 798 686.94 lire; deficit, 1 045 million 526 261.09 lire.

As compared with the previous financial year, traffic receipts showed, as a result of the increased rates, a total increase of 879 660 000 lire, or an average increase of from 0.513 to 0.814 lira per axle-kilometre, or from 123 666 to 173 870 lire per kilometre of line. Other receipts decreased by 43 377 000 lire, and miscellaneous receipts by 177 931 000 lire.

The expenditure on staff increased from 1 270 661 000 to 2 009 832 000 lire, due partly to the increased number of employees and partly to increased wages. The average annual wage increased from 6 498 to 9 553 lire.

The expenditure on fuel for steam traction increased from 977 993 000 to 1 128 180 000 lire; and the average cost per ton increased from 397.84 to 417.86 lire.

Various items of expenditure borne by the administration were : 9 367 000 lire for the boat service across the Straits of Messina; 11 013 000 on the light railways of Sicily; 3 507 000 on the Palermo-Corleone railway; and 16 million 168 000 on the railways of Sardinia.

In the aggregate, the special charges

which, whether for political reasons or force majeure, had to be borne by the railway administration, are estimated at 2 542 883 000 lire, or 62.2 % of total working expenses.

The ratio of working expenses to gross receipts was 138.69 %. The general results of the year for the standard gauge system (excluding the Dalmatian lines) show a certain reduction in goods traffic and in the net load of the trains: the former was due to industrial and commercial depression; the latter to the increase of underloading wagons with goods traffic. The net load, however, still remained considerably higher than before the war. There was, on the other hand, a greater number of passengers, marked by a considerable increase in the proportion of third-class passengers as compared with those of the first and second classes.

The train-kilometres for passengers and mixed trains increased from 46 million 886 677 to 49 236 254 (29 134 537 to 30 594 522 train-miles); and for goods trains, and trains carrying materials for construction, from 49 330 008 to 52 million 175 545 (30 652 279 to 32 420 945 train-miles).

The average loading of goods and cattle per working-day increased from 119 041 to 119 405 tons, and from 11 378 to 11 913 wagons; corresponding to an increase of wagons from 0.742 to 0.762 (1.194 to 1.226 per mile), and a decrease of tonnage from 7 766 to 7 640 per kilometre (12.498 to 12.295 per mile).

The total goods returns for the year were 3 871 790 wagon-loads and 38 million 806 714 tons, or an increase of 2.21 % in the number of wagon-loads and a decrease of 2.32 % in tonnage.

The axle-kilometres for loaded wagons decreased from 1 990 229 869 to 1 792 878 915 (1 236 693 016 to 1 114 million 62 859 axle-miles). The ton-kilometres of goods carried also decreased from 9 795 568 000 to 8 620 523 000 (6 086 million 798 600 to 5 356 637 800 ton-miles), or, on an average, from 639 022 to 551 608 per kilometre (1 028 384 to 887 708 per mile), largely because of the gradual return to normal conditions as regards the average length of journey, which decreased from 246 to 222 km. (153 to 138 miles). The average load per axle decreased from 5.043 to 4.899 tons, and the average weight of trains from 313.6 to 289 tons in the case of steam traction, and from 295 to 247.3 tons in the case of electric traction, the final figures being, however, higher in each case than the corresponding figures for 1913-1914, which were respectively 4.267, 235.1 and 191.6.

The fuel consumption per locomotive-kilometre increased from 20.16 to 21.06 kgr. (71.52 to 74.71 lb. per locomotive-mile), in spite of the lower average load, either because of the inferior quality of the fuel used or of less economical working.

The running of passenger trains showed considerable improvement during certain periods of the year, but we as a whole irregular as the result of the disturbing factors to which reference has already been made; and the same was the case with goods trains. The number of accidents was considerably reduced.

There was, finally, a further notable increase of damaged, stolen or lost goods. The compensation paid under this head amounted to about 98 million lire, account being taken in this figure of the general increased price of goods.

* * *

The financial year 1921-1922 was even more unfavourable than the preceding year, but it was marked on the other hand by an encouraging return towards a more settled feeling among the personnel and a notable improvement in the regularity of the train service.

Among the various favourable characteristics of the year may be noted an appreciable reduction in the number of

employees and an increase in passenger traffic.

Various reforms were considered, and in some cases adopted, with a view to simplifying working and reducing expenditure. The benefits realised by these reforms will make themselves felt in subsequent balance sheets.

Development of traffic; rates. — The total length of line as at the 30 June 1922 was 15 640 km. 166 (9 718.518 miles) standard gauge and 878 km. 369 (545.803 miles) narrow gauge, including the Libyan railways. The length of new line opened up during the year was 35 km. 156 (21.845 miles) standard gauge, and 28 km. 235 (17.545 miles) narrow gauge.

There was no increase in rates. On the contrary, appreciable reductions were made for certain classes of goods (cereals, wine, coal by-products), and several reductions were made in passenger fares, while various former facilities were reintroduced as regards the passenger service.

On the 1 January 1922 certain modifications were introduced with a view to simplifying rates and co-ordinating them with international regulations.

Personnel. — The suspension of the engagement of new employees by the application of the law of August 1921 which dealt with the reorganisation of State administrations, in addition to considerable retrenchment consequent on a general scheme of reform, including the reduction of the number of temporary employees, made it possible to reduce the personnel (navigation service excluded) by 10 797 employees, or by 4.5 % as compared with the figure for the preceding year. This was done in spite of the obligation to find employment for about 5 600 men incapacitated by the war, according to the agreement entered into with the government the previous year; and in spite of the increase of 9.2 % in the number of axle-kilometres recorded, that is to say, in the actual work accomplished.

The number of railway employees (excluding the personnel of the railways of Sicily and Libya and of the navigation service) was reduced from 229 078 (30 June 1921) to 219 855 (30 June 1922), or, on the average of the year, from 14.66 to 14.06 per kilometre (23.59 to 22.63 per mile) of line.

These reductions, however, as far as the balance sheet is concerned, only made it possible to restrict within certain limits the increase of expenditure resulting from the new economic situation.

Towards the end of the year various modifications were effected in the duties of locomotive and train staffs with a view to increasing their efficiency and contributing towards a more regular and economic system of working.

The new regime of the eight-hour working-day and the weekly rest-day was extended to the inspection staff (the only category to which it had not yet been applied); and this resulted in a further increase in personnel, as it was applied concurrently with the reforms effected with a view to reducing the cost of supervision of the permanent way and level-crossings.

Way and Works. — The ordinary work on the maintenance of the permanent way was greatly increased, and the experiment of executing this work by contract was extended with a view to economy.

Important work on the improvement and upkeep of the permanent way; new constructional work on the lines, in the stations, workshops and depots; the renewal of rails, and the installation of mechanical safety appliances also made considerable progress. The same was the case as regards electric and hydro-electric installations, and the construction of new lines. The electrified system was increased by about 161 km.

(100 miles) of new lines (from Pignérol to Torre Pellice, from Bricherasio to Barge, from Trofarello to Alessandria and Ronco Scrivia, branch lines at the port of Genoa); and, as has already been mentioned, about 63 km. (39 miles) of new lines were inaugurated (from Russi to Faenza, from Granarolo to Lugo, direct from Ronco to Arquata, standard gauge; and from Favara to Margonia and Cianciana to Magazzolo, narrow gauge).

For the preliminary work necessary for the construction of new lines, and for the completion of lines in course of construction, further sums were allotted, amounting to about 447 million lire, the new allocations in the balance sheet amounting to about 273 millions and the future commitments to about 176 millions.

Commitments amounting to 92 million lire were undertaken in respect of the railways of Sardinia, largely for the improvement of existing lines.

Rolling-stock. — The amount of rolling-stock per kilometre of standard gauge line continued to increase, the figures rising from 0.419 to 0.426 (0.674 to 0.686 per mile) for locomotives, from 0.704 to 0.718 (1.133 to 1.155 per mile) for carriages, from 0.299 to 0.307 (0.481 to 0.494 per mile) for luggage-vans, and from 9.488 to 9.587 (15.269 to 15.428 per mile) for wagons.

The construction of new-rolling-stock, which was entirely in the hands of private firms of the country, was considerably greater, as regards locomotives and carriages, than in 1920-1921, the output being 255 steam locomotives, 24 electric locomotives, 570 carriages, 224 luggage-vans, and 2 017 wagons.

The increases in the amount of repairs to rolling-stock was still more marked, especially in the case of private firms, where the output exceeded that of the preceding year by 58 % for locomotives and 48 % for wagons.

The quantity of rolling-stock withdrawn from service for repairs still remained somewhat high, however, because of its excessively deteriorated condition, although the average percentage out of service decreased from 30 to 27.6 % for locomotives, 35.1 to 33.5 % for luggage-vans, and 17 to 15.2 % for wagons. There was an increase of from 38.6 to 40.3 % in the number of carriages under repair.

Taken as a whole, the average amount of rolling-stock in running order per kilometre of line increased from 0.301 to 0.305 (0.484 to 0.491 per mile) for locomotives, and from 9.095 to 9.534 (14.637 to 15.343 per mile) for wagons. The amount available was in any case sufficient to meet requirements.

Financial results. — The financial results in respect of the standard gauge and narrow gauge system comprised within the former frontiers of the Italian State (including the service across the Straits of Messina) and of the navigation service were receipts of 3 035 612 285.40 lire and an expenditure of 4 293 million 558 594.58 lire. The deficit of 1 257 million 946 309.18 lire exceeds that of the previous year by 212 420 048.99 lire; but a large part of the difference, *viz.*, about 155 millions, is attributable to the variation in the value of the coal in stock as compared with that shewn in the balance sheet for the year 1920-1921.

Traffic receipts as a whole increased by 97.4 million lire (from 2 695.4 to 2 792.8), there being a decrease of 2.1 millions from goods traffic and an increase of 99.5 millions from passenger traffic.

Of this latter increase, only 47.1 millions is attributable to increased rates; it indicates, therefore, an actual increase in traffic.

The receipts from military transport decreased from 129.1 to 24.4 millions.

The expenditure on staff, in spite of a considerable reduction in the number of employees, increased from 2 009.8 to

2 275.7 millions as a result of the complete introduction of the new rates of pay and payment of arrears; the average rate of pay per employee per annum increased from 9 553 to 10 946 lire.

There was a reduction from 1 128.2 millions to 694 millions in the expenditure on fuel for steam traction on the principal railway system; the average price of fuel decreased from 417.86 lire to 243.44 lire per ton.

The cost of maintenance of rolling-stock increased very considerably, from 470.3 to 730.1 millions.

Various sectional items of expenditure met by the railway administration were: 4.6 millions for the service across the Straits of Messina; 19.1 millions for boat services to the islands; 12.3 millions for the secondary railways of Sicily; 2 millions for the Palermo-Corleone line; 12.5 millions for the railways of Sardinia.

Working expenses amounted to 1.10 lire per axle-kilometre and 38.96 lire per train-kilometre.

The ratio of working expenses to gross receipts was 136.21 %, a decrease of 2.48 % compared with the previous year.

Traffic. — The number of train-kilometres for passenger and mixed trains for the whole of the standard gauge system increased considerably, *viz.* from 49 236 254 to 59 073 948 (30 594 523 to 36 707 488 train-miles), as a result of the development of the train service. Passenger traffic was proportionately greater, as we have already shown in referring to receipts.

The number of train-kilometres for goods, material and service trains decreased slightly, *viz.* from 52 175 545 to 52 079 991 (32 420 945 to 32 361 569 train-miles). In the case of goods trains taken separately, the figure decreased from 52 004 441 to 51 851 065 (32 314 624 to 32 219 318 train-miles), while the axle-kilometres for loaded wagons increased from 1 792 878 915 to 1 824 301 235 (1 114 million 62 686 to 1 133 587 950 axle-miles), indicating a fuller loading of trains.

The average loading of goods and cattle per working-day, continuing the increase recorded during the previous year and rose from 11 913 to 13 446 wagons, and from 119 405 to 127 846 tons; and during the last two months of the year it almost equalled the maximum number of wagons — about 15 000 — of pre-war days, and even exceeded the pre-war record as regards tonnage, the maximum reached being 142 273 tons in the month of June, the maximum for 1913-1914 being only 127 990 tons. The figure for loaded wagons per kilometre of line increased from 0.762 to 0.860 (1.226 to 1.384 per mile), and the total goods despatched per working-day increased from 7.640 to 8.176 tons, the corresponding figures for 1913-1914 being 1.071 and 8.33 (1.723 and 13.405 per mile) respectively.

The total loading of the year was 4 382 565 wagons, an increase of 13.19 %, and 41 677 670 tons, an increase of 7.40 %; this tonnage, leaving out of account the extension of the railway system, exceeded that for 1913-1914.

The approximate number of ton-kilometres of goods carried showed a very slight reduction, *viz.* from 8 620 523 000 to 8 598 121 000 (5 356 637 800 to 5 342 million 717 600 ton-miles), or from 551 608 to 549 682 per kilometre (887 708 to 884 609 per mile) of line, due to the gradual return to normal conditions as regards the average length of journey, which further decreased from 222.14 to 206.41 km. (138.03 to 128.26 miles).

On the whole, and in spite of the decrease in receipts, there was some increase in goods traffic. The only falling off was in military transport.

Various features of the year's work. — The average load per axle again decreased slightly (from 4.899 to 4.843 tons) as a result of the increase of underloaded wagons; and the average weight of trains

decreased, from 279.4 to 264.7 tons in the case of steam traction, and increased from 247.3 to 249.2 tons in the case of electric traction, the figure in each case being considerably higher than in 1913-1914.

The average journey of goods trains improved as compared with the previous year, falling from ten days and nine hours to nine days, as a result of better loading and running conditions.

Fuel consumption per locomotive-kilometre increased further from 21.06 to 22.51 kgr. (74.71 to 79.87 lb. per mile), notwithstanding the lower average weight of trains and the better quality of the coal used, the effect of the premiums on economy, reintroduced towards the end of the financial year, not having yet made itself felt.

The running of trains, especially passenger trains, and the general regularity of transport, showed considerable improvement, especially towards the end of the year

There was an increase in the number of accidents, due to the greater frequency of collisions at level-crossings following on the abolition of gate-keepers.

Finally, there was a decrease in the number of cases of theft of goods, although the amount of compensation paid under this head was higher, because of the higher prices of goods.

MISCELLANEOUS INFORMATION

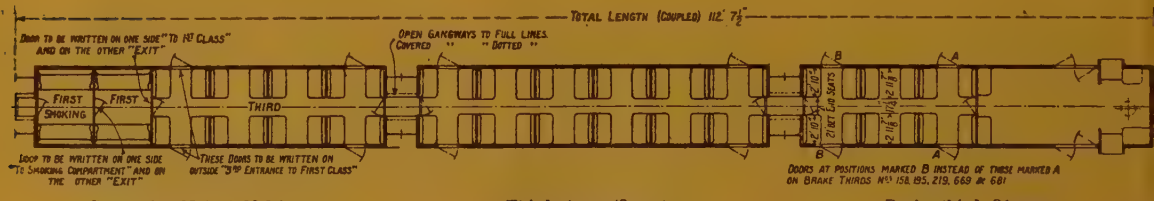
[656. 224 (.42)]

1. — « Conductor-guard » trains on the London & North Eastern Railway.

Fig. 1, p. 1044.

(From the *Railway Gazette*.)

The Great Eastern Railway adopted the « conductor-guard » system more than a year ago, and in conjunction therewith, have developed the « halt » system to an interesting degree, including the provision of rail level « halts » of a very inexpensive character served by « conductor-guard » trains. In some instances the « conductor-guard » system is used with rolling-stock consisting of two or three standard corridor vehicles with connecting gangways, but, in the ordinary way, special sets, generally corresponding to those introduced some years ago for use on the Kelvedon & Tollesbury and Elsenham & Thaxted Light Railways are used. The new sets, although consisting of adapted six-wheeled vehicles, include a number of improvements and provide a very convenient and compact form of train, well designed and upholstered and fitted in accordance with present standard practice.


TOTAL LENGTH (COUPLED) 112' 7½"
DOOR TO BE WRITTEN ON ONE SIDE "TO 1ST CLASS" AND ON THE OTHER "EXIT"
OPEN GANGWAYS TO FULL LINES. COVERED " DOTTED "
FIRST SMOKING
FIRST
THIRD
LOOP TO BE WRITTEN ON ONE SIDE "TO SMOKING COMPARTMENT" AND ON THE OTHER "EXIT"
THESE DOORS TO BE WRITTEN ON OUTSIDE "3RD ENTRANCE TO FIRST CLASS"
B
A
21'0" 24 SEATS
21'0" 24 SEATS
DOORS AT POSITIONS MARKED B INSTEAD OF THESE MARKED A ON BRAKE THIRDS Nos 158, 195, 219, 669 & 681

Composite, 12-1st & 32-3rd seats. Weight, 13 t. 3 c. 0 q. approx.

Third class, 48 seats. Weight, 13 t. 3 c. 0 q. approx.

Brake third, 24 seats. Weight, 12 t. 16 c. 2 q. approx.

Fig. 1. — Floor plan of new « Conductor-guard » train, London & North Eastern Railway.

By courtesy of Colonel H. H. Mauldin, superintendent of operation, and Mr. A. J. Hill, chief mechanical engineer, and their assistants, we are able to give a plan of one of the new « conductor-guard » sets. These differ from the light railway sets in that first-class accommodation is provided as well as third. For the former, two compartments, one « smoking », each seating six passengers, are provided, the seats being arranged longitudinally and public entrance being obtained through the adjacent third-class door, which is lettered « 3rd, Entrance to First Class », the compartments being then reached through ordinary interior doors. The remainder of this vehicle is of semi-open type, with eight seats arranged back to back on either side of a central passageway, and accommodating altogether 32 third-class passengers. Only the doors of the end sections are used. A second vehicle provides for 48 third-class passengers, and is semi-open throughout, with a central passageway, the end doors only being retained. The third vehicle is also for third-class passengers, and is semi-open, in three sections, the centre door being fitted, where used for serving the new « halts » with steps on one side. The remainder of this vehicle

provides guard's and brake accommodation. The vehicles of each set are connected by simple gangways, with protecting rails, intended for the use of the guard only, to enable him to proceed through the train and issue tickets. Further vehicles are, of course, added when necessary, and, when required, luggage, milk or other vans can be attached. As newly adapted and upholstered, the accommodation is quite up to modern standards.

Notices are provided inside vehicles on the branches serving the new halts, stating that « Passengers for —— Halt (or Halts) must not attempt to alight until the steps have been fixed and the guard has opened the door ». The brake third vehicle so adapted is also labelled for the use of passengers at the halt (or halts) named.

[656 .257 (.42)]

2. — A notable interlocking replacement.

(*Railway Gazette.*)

By the courtesy of Mr. John Miller, chief civil engineer, and Mr. W. H. Bird, signal engineer, Great Eastern Section, London & North Eastern Railway, we are able to describe briefly the methods adopted for the installation of entirely new locking mechanism in place of, and carried by the same supports as, the old locking of a complicated 136-lever frame at the East Side signal-box at Liverpool Street station, without requiring hand-signalling to be introduced and without interrupting or necessitating any modification of traffic dealt with in the East Side section of that busy terminus. Owing to the fact that all Sunday traffic is usually concentrated in the older portion of the station, it was possible to obtain exclusive possession of the East Side for a period of thirty two hours, an important factor rendering the methods adopted practicable, but, even allowing for that, it was a notable achievement to undertake and accomplish successfully the transport of a complicated interlocking for 136 levers and measuring nearly 50 feet in length, permanently assembled, and to place it in position without a hitch or the slightest distortion or displacement.

The interlocking, which was necessarily of a complicated character, and one which it would have been difficult to assemble on the spot, was built up and tested in the signal workshops at Leyton, the only special factor being that it was designed with a view to its division lengthwise to facilitate transport. By means of rollers and skids, each section was in turn transferred to a long flat truck and conveyed to Liverpool Street by special engine on the Sunday 27 May 1923. It was necessary to obtain exclusive use of the turntable for a short time, but otherwise there was no interference with ordinary traffic. Transferred from the truck to trestle work in line with the door, and a temporary cut made in the wall of the signal cabin, the first portion of the interlocking was rolled into the basement, and, when the second part had been similarly dealt with, the two sections were joined up, and the whole rolled into a position above the old interlocking. That was in two tiers, but the new mechanism was designed to be complete in itself, so that only one level had to be considered. The new locking is also very much more compact, as well as incorporating many improvements and covering certain alterations. The mechanism was then raised by hangers attached under the floor of the cabin and thus suspended over the old mechanism during the intervening week.

From Saturday, 2 June, at 10 p. m., possession of the East Side station was obtained. By 12.15 a. m. on Sunday the upper tier of the old locking had been dismantled and the lower tier disconnected and removed as far as necessary. The new locking was then lowered to the supports which had carried the upper tier of the old locking and connected up, this, together with adjustments, being completed by 8.30 a. m. Tests of the new locking, etc., alterations in the outside connections,

and other details, were completed by 7.15 p. m., and the work was virtually completed by 10 p. m., twenty-four hours after possession of the box had been obtained. At 5.50 a. m. next morning the box was handed back to the Operating Department, ready for the first train booked into the East Side station on Monday.

As far as we can gather, no replacement on so large a scale, and comparable in character and circumstances, has ever been carried out by similar methods in so short a time or without requiring hand-signalling and temporary working methods. As such, Mr. Miller and Mr. Bird are to be congratulated upon the notable achievement thus accomplished.

[385. (09 (.498)]

3. — The recovery of the Roumanian railways.

Mr. Tancred Constantinescu, director general of the Roumanian State Railways, recently gave some interesting information in London, of which we give the following account, on the remarkably rapid recovery of these railways :

At the end of the war, the country, which was in a devastated condition, was left almost entirely without railways, bridges, or roads, and not more than 100 trains were running each day throughout the whole of the country. Everything had to be reconstructed. During the period 1918 to 1920 the progress of reconstruction was slow and unsatisfactory. At the end of 1920, several influencial foreign syndicates entered into negotiation with the Government to obtain the control of the workshops and to carry out all the railway work, undertaking to employ as far as possible Roumanian engineers and skilled workmen. These proposals, although they were favourably received by the Government, were opposed by Mr. Bratianu, who maintained that under a capable administration, Roumania ought to be able to itself restore its own railways, and he aroused such a strong opposition, that in spite of political influences and financial support, the negotiations with the foreign syndicates were not proceeded with. As soon as Mr. Bratianu came into power, military control of the railways was withdrawn, and Mr. Constantinescu was put in charge with unlimited powers, and with urgent instructions to put the railways into a satisfactory condition as being a matter of vital interest to Great Roumania.

From this time the activity displayed by all branches of the railway administration has been remarkable.

Repair of rolling stock. — Although in 1919 and 1920 the repairs to the permanent way had been relatively insignificant, in 1921, 600 000 sleepers were renewed, and in 1922, 1 860 000 sleepers and 1 500 000 will be replaced in 1923; half of this work having been already done at this time. Repairs to rolling stock have been carried on on an equally large scale, and 119 locomotives have been overhauled (on the average) per month in 1922, in place of 116 in 1921, and 5 000 wagons have passed through the shops in place of 3 000, while 10 000 wagons have been repaired by travelling gangs in place of 4 550. This rate of progress is being maintained in 1923.

Permanent way. — On the other hand, a large number of junctions have been laid out or relayed, as well as important shunting facilities, and sorting and storage sidings. Branches and other works which were destroyed during the war have been reconstructed. The lines in Northern Bessarabia which were of the Russian broad gauge have been converted to standard gauge.

Traffic. — As regards the traffic, the number of wagons loaded per month has increased from 68 000 in November 1921 to 122 000 in

November 1922. The total tonnage carried has increased in the same period from 9 million tonnes to 15 millions, and the train-kilometres from 90 000 to 120 000 (from 56 000 to 75 000 train-miles), and has since maintained itself in the neighbourhood of the latter figure. It is true that the railway now possesses 2 000 locomotives in place of 100 at the end of the war, and this allows 410 passenger trains and 510 goods trains to be run daily.

Receipts. — The traffic receipts have increased in accordance with the improvements which have been effected. The average monthly figure has increased from 29 131 611 lei to 62 473 544 lei in 1920, to 119 177 194 lei in 1921, to 206 095 899 lei in 1922, to 282 711 827 lei in May 1923 and in June (for 30 days) to 279 413 346 lei (although it is true as regards the latter figures, 50 millions are due to the last increase in transport rates).

At the present time the development of the traffic unfortunately is being hampered by the lack of fuel, and in 1923 the situation had become more difficult on account of the continual rise in price of material and labour.

It will be necessary to raise additional credit if it is intended to cope with the economical requirements of the country.

M. P.

NEW BOOKS AND PUBLICATIONS

[385, (09.1 & 385. (04]

GAIRNS (J. F.), M. I. Loco. E. — **Railways for all.** — One volume 8vo (8 × 6 inches) of 384 pages with 100 illustrations. — 1923. — Published by Messrs. Ward, Lock & Co., Ltd., London and Melbourne. — Price : 6 sh. net.

This book is the first of a series which are being published under the general title of *Books for all* and which are designed primarily for older boys and girls and for students.

The present volume is perhaps the most comprehensive one that has ever been published in England on the subject of railways, and is written in a very readable style by an author who has had very considerable experience in writing on railways from a popular point of view.

It will be appreciated that in spite of the size of the book — and the paper used makes it thick — there is little space for any one of the multitude of subjects dealt with in its thirty-nine chapters, each of which deals with a definite and different subject.

The railways chiefly dealt with are those of Great Britain, and throughout the book the railways are wholly spoken of in their new grouping.

It must not be supposed that Foreign or Colonial railways are wholly neglected, as in all cases when they present different points they — especially the American railroads — are dealt with.

After the first two chapters, which deal with types of railways and their early development, there is a series of chapters dealing with the locomotive and its details, carriages, wagons and other rolling stock. Three chapters follow on the types of signals and systems of signalling from early times until the present day.

Chapters are devoted to timetables and working the trains, electric traction and tubes. A short chapter is all too brief in dealing with how railways have changed the world.

Ten chapters deal with the construction and civil engineering of railways, and interesting particulars are given of the greatest bridges and tunnels of the world, although it is somewhat surprising that special attention is not given to the tunnels under the rivers which connect Manhattan with the mainland and Long Island at New York.

The remainder of the book consists of a series of chapters dealing with various phases of railway work, including a short one on « Railways and the Great War ».

The book is one which will prove a delightful and delighting present to any young person, and has the great advantage of being written by one who is not only readable, but correct — with the exception of one or two « printer's » errors — in his facts.

It should be mentioned that the type is good, as are the illustrations.

In view of the proposed visit of the International Railway Congress Association to London in 1925, the little known caricatures of *Punch* of the « Frescoes of the opening of the Railway Parliament, 1845 » are particularly interesting.

H. F.

[385. (03 & 385. (04]

SERRAILLIER (L.). — **Railway technical vocabulary (Vocabulaire technique des chemins de fer).** — One volume 8vo (7 1/2 × 5 inches) of x + 222 pages with 22 tables. — 1918, Whittaker & Co., Whitehart Street, Paternoster Square, London E. C. 4, and 66, Fifth Avenue, New York. — Price : 7 sh. 6 d. net.

The *Railway Technical Vocabulary* of Mr. L. Serraillier deals with French, English and American words. It is unnecessary to speak of the importance of a work like this, as every railway engineer is interested more or less in such a work. Most of the technical railway words are in fact new ones and have been adopted by degrees according as the need and progress of the industry has made it necessary. This makes it very difficult to read an article written in a foreign language without constant references to dictionaries over a word which is often a very simple one. In addition, as Mr. Serraillier says in his preface : « It is to be hoped also that some understanding may ultimately be arrived at by which either a process, operation, or appliance shall be know by one name only in each language, so as to avoid the confusion and uncertainty which often arise when various expressions, denoting the same object, are adopted by different railways in the same country. »

The author has grouped the words according to the subject, and this seems preferable to giving them alphabetically. This allows of the words relating to the same apparatus being given together. The work is divided into seven sections, *viz.*, Class of Railway, Administration, Traffic, Way and Works, Locomotives and Rolling Stock, General, and Tables for conversion from metric figures. We think, however, that the value of the Vocabulary would be increased if a separate list, with translations in both languages in alphabetical order, were given at the end. This list might be printed in small characters and would take up very little space. We trust that in the next edition, which should not be long before it appears, the Vocabulary may be extended to other languages, such as Italian, Spanish and German.

J. V.

[385. (09.1 & 385. (04]

THE RAILWAY GAZETTE and Railway News. — **Special Indian Railway Progress Number.** — One pamphlet, large octavo (11 3/4 × 9 inches) of 108 pages with numerous figures and 150 photographic reproductions. — Number of 17 September 1923, published by the Editorial Staff of *The Railway Gazette*, 33, Tothill Street, Westminster, London, S. W. 1. — Price : 5 s. net.

The « Special Indian Railway Progress Number » just issued by the *Railway Gazette*, 33, Tothill Street, Westminster, S. W. 1, has been published at an opportune time. For several years the Indian Railways, while developing their facilities as much as possible, have been hindered in their endeavours by Government interference with the Budget allocations for railway improvement works. Since, however, as a result of the Acworth Report (1), a large annual sum has been allocated for railway purposes over a period of five years, the administrations have been able to proceed with development programmes, and, in this special issue, considerable information is given as to the nature of the

(1) Vide *Bulletin of the International Railway Congress Association*, November 1922, p. 1443.

main improvements now being carried out or projected.

The potentialities of India will be realised when it is pointed out that, whereas Great Britain with approximately 50 000 000 population has 20 000 miles of railways, or 22 miles per 100 square miles of territory, and 48 miles per 100 000 inhabitants, India, with approximately 330 000 000 population has no more than 37 000 miles or 2 miles per 100 square miles of territory, and 12 miles per 100 000 inhabitants. The comparison is still more unfavourable to India if the railways in the two countries are reduced to single track and analysed. Moreover, on the basis of population, which is a reasonable indication of trade and therefore of railway traffic, India should have more than four times its existing railway mileage to equal the railway position in Great Britain.

India's railway problems are each discussed editorially, including the proposed grouping schemes (with especially prepared maps), leading up to a series of authoritative articles describing recent developments, new works completed, in hand, or proposed, together with 150 illustrations (on art paper) covering all phases of working on the respective systems. Much of the material has not hitherto been presented in collective form. Special interest attaches to the numerous plans of railway improvement works, manufacturing establishments (with particulars of machine tool and other equipment), traffic and operating data, and information in regard to locomotives and passenger and freight rolling-stock, covering virtually all modern designs. A directory of Indian Railways completes this valuable and well-produced publication.

[62 (03 & 385. (04]

LVOFF (M.). — **The engineers' pocket technical dictionary**, French-English. — One volume 8vo (6 1/2 × 4 inches) of 150 pages. — 1923, Published by Messrs. E. & F. N. Spon, Ltd., 57, Haymarket, London, S. W. 1, and Messrs. Spon & Chamberlain, 120, Liberty Street, New York. — Price : 3 sh. 6 d.

This dictionary fulfils a long felt want, as it gives in a concise form the English equivalents of French technical words which are not found in ordinary dictionaries; the French terms being arranged in alphabetical order, but where words are used to form compound expressions, the more important of these follow immediately after the words which they are compounded.

It includes terms used in mechanical and electrical engineering, railway work, steel and iron industry, aeroplane, motor and cycle trades, etc., as well as commercial expressions used in contracts and specifications.

D. W. S.

[656 .25 (02 & 385. (04]

Railway signal and permanent way engineers' pocket book, 2nd edition. — One volume 8vo (5 1/2 × 3 1/4 inches) of 326 pages with numerous illustrations, diagrams and tables in the text. — Published by The Locomotive Publishing Co., Ltd., 3, Amen Corner, London, E. C. 4; Spon & Chamberlain, 123, Liberty Street, New York, and *The Indian Railway Gazette*, 6, Mangoe Lane, Calcutta.

This little book contains, in a concise form, a very large amount of information on signalling, railway telephones and telegraphs, and permanent way engineering.

The first part, which deals with sign-

alling includes the following principal subjects : British Board of Trade requirements as regards railway signalling, a description of the various types of signals with the purposes for which used and their details of construction. Electrically operated banner signals, repeaters, route indicating signals, detonator laying machines, etc., are described and illustrated.

Useful information is given as regards the construction of signal boxes.

Methods of signal lighting are discussed with descriptions and illustrations of various oil, gas, electric and flash lamps.

Various types of locking frames are illustrated, and information given on wires and point rods, and compensation devices used in the same.

Power signalling systems are described, including electro-pneumatic, all-electric and electro-mechanical; notes on the maintenance of each of these systems being given.

Track circuit and automatic block signals are fully dealt with.

Considerable space is devoted to a description of block instruments, both for double and single line, the latter including tablet instruments, electric occupation key system, etc.

Nine pages are devoted to cab-signalling and train control descriptions being given of « Prentice » System, Great Western System, Raven's Apparatus, and Tyer's Automatic Train Control System.

Useful notes and wiring diagrams are given for railway telegraph and telephone work.

The second part deals with permanent way work. Extracts from the British Board of Trade Regulations as affecting permanent way are given.

There is considerable information on rails, including particulars of the British Standard Specification for bull headed rails.

Useful information is given on sleepers, chairs, keys and fishplates, dealing both with design and manufacture as well as their actual use.

Five pages are devoted to the design and methods of construction of points and crossings. Notes are given on the laying out of curves, both circular and transition curves, and also on the calculation of point and crossing angles.

Notes are included regarding permanent way maintenance of electrified track.

The book concludes with tables of metric equivalents, with notes on the preparation of railway plans and surveys, and with a vocabulary of signal and permanent way details in English, French, Spanish and Italian.

It must be admitted that the Publishers have been successful in compressing an extraordinarily large amount of information into a small space.

D. W. S.